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MOTORSHIP

(Trade Mark Registered U. S. Patent Office.)

Devoted to Commercial and Naval Motor Vessels

Vol. 3 APRIL, 1918 No. 4
SEATTLE NEW YORK

First of the fleet of 8100-tons D.W.C. standardized steel Diesel-driven Motor ships building at the Ansaldo shipyard, Genoa, Italy. for the Societa Nationale di Navigazione

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MOTORSHIP

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Vol. 3 SEATTLE, U. S. A., APRIL, 1918 No. 4

Electrical-Drive for Diesel Motorship Propulsion

A New Light on an Old Subject

By AN ENGINEER

The steam-engine merely is a transmitter of power and it is not a power producer and be the fuel supply ever so plentiful it cannot generate power; but only can transmit power produced by heat from water in a boiler to the propeller shaft. The internal-combustion-engine is a power producer and directly transmits its own power to the propeller shaft, hence the use of any intermediate means of power transmission is equivalent to turning the Diesel engine into a boiler. But, both use the same fuels. These differences in principle have to be taken into consideration when figuring upon electrical drive for ocean-going ships.

TO quite a few of us the question of electrical transmission of propelling-power aboard ship always has been absorbingly interesting; and, although there have been many experiments and many trials with Diesel-electric vessels of moderately large size and power the problem as yet has not satisfactorily been answered. The announced success of the U. S. steam-driven collier "Jupiter," (which has electrical transmission) once again has caused shipowners, naval-architects, and marine-engineers, to seriously think of utilizing the electrical drive in connection with Diesel-driven cargo motorships. Several designs lately have been gotten out, including those by Wm. T. Donnelly of New York and by Z. Dickie of San Francisco.

While it must be admitted that electrical power offers many very attractive features, the naval-architect must not let the attraction of the advantages outweigh other problems that arise, without first thoroughly probing their relative values, both from an engineering standpoint and from an owner's aspect. The case of the U. S. S. "Jupiter" would really seem to be quite different; for, the main objective in her instance must have been economy of operation, rather than ease of maneuvering, because steam power is flexible enough for all ordinary maneuvering requirements of merchant ships.

Therefore, if economy be the principal objective of the electrical drive, its general use hardly can be the most desirable of systems for the propulsion of oil-engined motorships for reasons that presently will be explained. While many well-built and well-designed motor vessels have demonstrated themselves to have flexible enough maneuvering qualities for all ordinary marine purposes, and to have a reliability even better than the average steamer, it must be admitted that there undoubtedly have been some which unfortunately have not come up to the standard of the best. This, of course, has been due more to the lack of experience of individual builders rather than direct fault of the type of propelling power, and should be so discriminated.

In other words, if all Diesel-driven vessels were developed to the degree attained by the best, there absolutely would be no need for any system of power transmission between the propeller-shaft and the engine, at least so far as flexibility and reliability are concerned. But, if it be possible to attain further economy, then every effort should be made to develop and utilize electrical transmission-drive. Failing reasonable promise of economy, is it not logical that the use of electrical, pneumatic, and hydraulic power transmitters, or any form of reduction gears, are not the truly ideal lines of development to follow; also would not their use at all only be a temporary expedient or subterfuge?

Perhaps all of us do not grasp with its deserved intensity the fact that the steam-engine merely is a transmitter of power, and that it neither is a power producer nor a power generator. And, instead of developing power it actually absorbs much of the power while transmitting the same. In other words, a steam-engine without its boiler cannot produce power and it is the boiler that produces the power from the fuel and water, and the steam-engine transmits it to the propeller shaft. Hence if electrical transmission is used in conjunction with a steam-engine, it merely means an increase in the number of power-transmitter units and does not change the basic functions of the engine or boiler.

How different is the case of the self-contained internal-combustion-oil-engine. This form of mechanism is a power producer in itself, and it directly produces and transmits its own power to the propeller. That is why it only uses one-third the quantity of oil-fuel. Utilizing an electrical or other form of power transmitter in conjunction with a Diesel-type engine is equivalent to turning the latter into a boiler, because it then merely acts as a generator of power from the fuel, and does not transmit the power direct to the propeller. Seeing that one of the most beautiful features of the oil-engine is its dispensation of the boiler, it easily can be understood why it cannot be logical to utilize a separate power-transmitter thereof, and, which under ordinary maritime conditions such cannot be so economical as the direct drive. Incidentally all this should help marine men to understand what a wonderful engine the late Dr. Rudolf Diesel gave to shipowners and why they all should use every effort to encourage its perfection and world-wide adoption, instead of "picking holes" in it on every slightest opportunity as some unfortunately still do.

Let us all remember that an economical engine is an efficient engine, so an efficient engine is an economical power. And, as the greatest advantage of the Diesel engine is its remarkable economy, any lines of development should not be regarded as the ultimate aim that will impair this wonderful economy. This being so, shipowners should strive to make all designs of Diesel engines properly reliable, whereby they can be efficiently utilized when coupled direct to the propeller shaft. And let them co-operate and assist the oil-engine builder with that progressive and broad-minded end in view.

If the direct application of power at present be not everything to be desired, let us rapidly perfect it rather than resort to some intermediate means.

All this, of course, is more or less theorizing, so let us come down from the sky to the more practical side of the argument. But, let it first clearly be understood that these various remarks have no bearing whatever upon the use of electrical transmission of power for ships' auxiliary machinery, the requirements of which entirely differ. Electrical drive for the latter purpose is highly desirable for other reasons which need not be dwelt upon by the writer as he notes that they have been ably explained and discussed in previous issues of "Motorship," including the March issue of this year.

In the earliest days of the Russian motorship fleets, before ocean-going motor vessels were in service, there were no directly-reversible Diesel engines, consequently the Russian engineers were forced to turn to some system of transmission. For at least 14 tankers and warships of 500 to 1200 b. h. p. the electric drive was used, and for about 30 tankers and tugs of similar power pneumatic slipping clutches in conjunction with mechanical gearing were resorted to and both systems were found to answer the purpose, although neither had been developed at that time to a proper stage of reliability. In the first installation there were no means of coupling the three oil-engines to the triple screws, the electrical losses being sustained during the entire period of working. But with later craft a system was used whereby electro-magnetic clutches enabled the oil-engines to be coupled to the tail-shafts when their respective speeds of rotation were equal, the electrical losses being present only during the astern motion and a slow-ahead speed.

However, some years after the directly-reversible Diesel engine was successfully produced, and one by one the electrical-drive installations were gradually discarded, and replaced by reversible engines, and the Russians did not continue its use once they had decided that the reversible Diesel engine was sufficiently reliable. And in the same way they applied this treatment to the ships fitted with pneumatic slipping-clutches and gearing. Whether they were right or wrong in making the changes is not for the author to say without being more conversant with the details; but, the fact remains that they abandoned the electrical-drive for the direct-coupled, directly-reversible oil-engine. In about 1912 the Nicolaieff Dockyard were instructed by the Russian Admiralty to convert the obsolete cruiser "Rindo" (or "Ruenda") to Diesel power and electrical transmission was to be adopted for experiment purposes. The last time the author heard from the Dockyard they informed him that while the Diesel engines had been completed, there had been considerable delay with the electrical transmission machinery. There seems to have been no record of her have passed her trials, and apparently after this installation no further electrical drive devices were adopted for motorships by the Russians, and the large Diesel-driven revenue cruiser "Yastreb" has direct-reversible oil-engines.

English shipowners had an unfortunate experience with electrical drive with a Diesel cargo motorship some years ago. It was in 1913. At that time the author criticized in the technical press the claims made for the system, and about six months later the entire machinery was removed and replaced with the steam-engines and boilers. It was said that the electrical transmission was faulty, other reports said that the Diesel engines also gave some trouble. Yet the entire ship was the result of a combination of a leading shipbuilder, Diesel-engine builder, electrical manufacturer, and experienced shipowners. Everything of the best as it were.

She was a vessel of 600 b. h. p. from two high-speed stationary type Diesel-engines, which were coupled to generators, the latter supplying current for a single electric motor coupled to the propeller-shaft of the ship. But only 500 b. h. p. was transmitted so there was a direct loss of 100 b. h. p., which is a considerable percentage of the total power. This ship was designed for the Great Lakes but never reached this continent.

It may be interesting to repeat the criticism made by the author in 1913 before the owners decided to remove the machinery and install steam-engines, as follows:

The claims put forward by the designer were as follows:

1. It adapts the speed of the engine to the speed of the propeller.
2. It combines the power of separate engines and the whole to a single propeller, with perfect freedom to use either or both power units.
3. It provides a simple and easy reversal of the propeller, while leaving the engines running in one direction at constant speed.
4. It also provides ready means of distant control, should this be required.
5. That the use of mechanical gearing performs the first and only of these functions.

"If careful reasoning is applied to the subject, it will be obvious that the whole principle, while it may work excellently, is hardly progressive, but would seem to be a distinct step astern, as, instead of improving the Diesel engine in order that it may perform these duties (that is, if it cannot

do them already), the arrangement allows efficiency to be obtained in a roundabout manner."

"Let us consider claim No. 1. The speed of the engine is adapted to the propeller speed, and even when the propeller is turning at half-speed the engine is still running at normal revolutions. At once we have an uneconomical system, for, when the vessel is moving slowly, as when entering harbors, locks, or docking, the engines will be consuming nearly enough fuel to drive her at full speed unless one is stopped altogether, whereas with a direct Diesel drive the fuel supply is cut down in order to get the necessary reduced propeller speed."

"Claim 2 is a doubtful advantage, as, with twin-screws, direct-driven maneuvering of the ship is greatly facilitated, and in the case of this ship there is only one propeller controlled by two engines. If one engine breaks down there is certainly the other to drive the propeller, but this is exactly the case with a twin-screw direct-driven boat. Now, if the sole propeller shaft breaks, the ship is helpless; but not so with twin screws, as with the direct-driven-Diesel ship "Jutlandia" recently."

"Claim 3 is another doubtful advantage, as modern reversible Diesel marine engines of the same power can reverse from full speed ahead to full speed astern in 5 seconds to 7 seconds. Even high-power machinery like that in the "Selandia" can reverse in 10 seconds and less."

"Claim 4 is a very good feature, although, by the way, the modern ship's telegraph is usually considered efficient, and it is necessary to always have engineers in the engine-room with any type of power vessel."

"Claim 5 is, perhaps, somewhat misleading, as mechanical gearing also performs claim 3, also claim 2, if such an arrangement were desired. In the Russian craft that had non-reversing engines, there was a slipping clutch at both ends, the forward clutch connecting up a mechanical reversing gear shaft running parallel with the engine, so that when the vessel was proceeding ahead the reverse gearing was entirely free, and was not absorbing any engine power. Also the clutches, by slipping, enabled any propeller speed to be attained with the engine running at normal revolutions if desired; but even this system is now out-of-date."

"Another feature open to criticism is that the Diesel engines of this ship are of the high-speed type, and therefore are not the most economical as regards fuel consumption. In direct-driven slow-running oil-engined vessels the fuel consumption varies from 0.38 lb. per b. h. p. hour to 0.47 per b. h. p. hour, while the consumption in the present case has unfortunately not been divulged; but, the shaft horse-power hour consumption must be very much higher. The fitting of steam auxiliaries is regrettable, as the running cost of such is greater than motor-driven electrical gear; but this really is a minor point, and more a question of personal preference. Naturally, the electrical transmission gear takes up a certain amount of room, thus the full advantage of cargo-space gain is not obtained. Again, the first cost of the machinery must be higher."

To this criticism the designers of the electrical equipment promptly replied, as follows:

"The criticisms are based chiefly on the five claims quoted, and which were put forward by the designer in his paper before the British Association. The critic, however, appears to have lost sight of the fact that these five claims were put forward not in justification of the ship alone, but of the general principle of electrical transmission for ship propulsion, and that in any particular installation it will, generally speaking, not be possible to realize to their fullest extent of all the advantages claimed."

"Taking the particular case of the ship we would justify the application of electric drive in this case as compared to a direct Diesel drive on the following grounds:

"It was recognized from the start that in a ship intended for lake and canal traffic a single propeller should be used. The superior claims of the single screw for the service conditions which obtain on the Canadian Lakes are indisputable; some very important advantages accruing being the higher propeller efficiency, the immunity from damages to blades when locking, and less erosion of the canal banks caused by the wash of the screw. It is obvious that with twin screws the athwartship width over the tips of blades will render them liable to damage from contact with dock walls, etc., also the erosion caused by the wash of the screw must be very considerable. The adoption, therefore, of a single screw running at the slowest practicable rate of revolution is a fundamental desideratum which was fully realized when the designs for this ship were in course of preparation."

"It being granted that a single screw is advisable, it is evident that operating at 120 to 140 r. p. m. behind a hull of this form it would have an extremely low efficiency, particularly so at the reduced speed of the vessel which obtains during canalling. To have run a direct-coupled Diesel engine at 80 r. p. m. would have involved prohibitive weight; it is doubtful whether any manufacturer would have produced within permissible limits of weight an engine running at such a low speed. To take the five claims quoted by your correspondent in order: (1) The engines can be kept running at full speed in the same direction of rotation, whilst the propeller speed is altered or reversed. Your correspondent misses one of the special advantages of the electric system by which during periods of running at half power, as in canalling, one of the engines and generators is shut down. Further, during brief periods of dead slow running, as in the direct Diesel drive, the supply of fuel would be cut off in order to reduce the speed, so in the case of engines driving generators will the fuel supply be cut off by the governor when the load is reduced. In the one case the reduction of the fuel supply has to be done by hand; in the other case it is done by the governor. We are quite at a loss to understand why your correspondent should call this an uneconomical system."

"(2) Criticism of claim 2 by your correspondent amounts to a comparison of the advantages of twin-screw over single-screw propulsion, and is applicable to all types of vessels irrespective of the prime mover adopted."

"(3) By the use of electrical transmission the operation of reversing is very simple, and dispenses with the extremely complicated and expensive mechanism which is an inherent feature of the reversible Diesel engine. It also permits of a large reduction of the air-storage capacity, particularly in the case of a vessel which has to be maneuvered frequently, and the exigencies of lake service demand frequent extended periods of maneuvering. The capacity of the auxiliary compressing plant is reduced to a minimum, in fact the auxiliary air compressor becomes only an emergency unit; and so far it has not been necessary to use it for charging on this ship."

"(4) Whatever advantages a system of remote control may possess can certainly be very easily realized in the case of an electrical transmission, whilst it would scarcely appear to be practicable with any other drive. There has, of course, never been any suggestion that remote control would enable any part of the engine-room staff to be dispensed with."

"As to the question of saving in weight and space it is found that with the Diesel engine as at present manufactured a smaller gain in weight is obtained by increased speed than would have seemed probable. No doubt the fact that the high-speed engines have been designed chiefly with a view to being used under conditions where weight was of minor importance has something to do with this, and there is reason to believe that an increased demand for light engines may conduce to considerable improvement in this respect."

In view of the above remarks, Mr. Editor, possibly you may be willing for engineers and shipowners interested to use your columns for the purpose of discussing the question at length for it is an important one. (We have referred to the matter on our editorial page.—Editor.)

THE GREI OIL ENGINE COMES TO AMERICA.

M. H. Tracy & Co., Inc., 17 State street, Chicago, have been appointed the American selling agents for the "Grei" motor and are anticipating a flattering reception for this invention for the reason that it has been developed to a point of perfection where many of the irritating engine troubles have been eliminated. The scarcity of motors and the present uncertainty of having same delivered, also insure this device a warm welcome as prompt deliveries can be promised. The "Grei," while unfamiliar to Americans, is not a new motor, having been standard in Norway for many years. It is manufactured by the oldest Norwegian motor building company, and will be a worthy competitor to the similar devices now used in this country.

The H type "Grei" motor is made in three sizes, from 4 to 10 horsepower. The G type is made in single cylinder in five sizes, running from 17-20 to 65-75 horsepower, and the two-cylinder G type is made in three sizes, 64-70 to 110-130 horsepower. These motors have features not possessed by other types. The fuel-controlling governor acts as a great fuel saver, giving either mechanical or automatic control, and they can be operated with or without water injection. No other hot-ball engine has these advantages.

The single cylinder motors use two-blade reversing propellers. The double cylinder motors are fitted with three-blade reversible propellers.

The 100-horsepower and larger sizes can be made in reversible type motor. All motors from 32-horsepower upwards are fitted with self-starting apparatus and the fuel consumption per horsepower runs from 20 per cent to 25 per cent less than with other motors.

A shipment of motors of different sizes has been made from Norway, and they will be placed on exhibition soon after their arrival, when they will be available for delivery.

LARGE GERMAN SUBMARINES.

According to our British contemporary three German submarines of 2,800 tons displacement each are believed to have been completed and these carry two 6" guns and that five duplicate craft are nearing completion. If this is the case these vessels are about twice the size of modern destroyers and have heavier armament. The output of standard 800 tons submarines is said to be 10 per month. Similar remarks recently were made by Mr. Marley F. Hay, the submarine designer. Personally we believe Germany is limiting her construction to 1,000-ton and 1,500-ton craft.

PROFITS FROM MOTORSHIP TRANSPORTATION.

Despite the internal troubles in Russia, the Nobel Bros. Naphtha Productions Company made a profit in 1917 of no less than 49,750,000 roubles, much of which was due to low transportation charges effected by the very large number of Diesel-driven tankers and tow-boats which this company operate. They have nearly one hundred motorcraft of 500 to 1,200 b. h. p. in service in addition to a large number of lower-powered craft. Nobel Bros. are associated with the Royal Dutch Petroleum Co. (Shell), who also are strong advocates of motorships and who have many ocean-going vessels in service. According to Richard Spillane of the N. Y. "Evening Mail," no matter the outcome of the war the Royal Dutch interests will be protected by the victors, both Great Britain and Germany being financially interested.

USE OF FISH OILS FOR OPERATING MOTOR VESSELS.

According to "Politiken," of Copenhagen, experiments have been made with motors for fishing boats to determine the practicability of using fish oils for operating motors. It is said that this has proved a success, and that it may be possible for the fishermen who now have boats equipped with kerosene motors to make some slight changes which will enable them to operate with fish oils. It is even proposed that the fishermen may make their own cod-liver oil while at sea for use in their motors.

The above statement was referred to Mr. Knudsen, manager of Burmeister & Wain, of Copenhagen, who writes as follows:

I take pleasure in confirming that the fish oil for Diesel motors will be excellent to use as a moving power. Further I beg to say that no doubt the said oil will also be practicable for smaller fishing boats where the motors do not work according to the Diesel principle, but the principle of explosive motors.

NEW GRACE MOTORSHIP.

The W. R. Grace motorship "Santa Flavia," in tow of a tug, arrived at San Francisco with a load of lumber from Aberdeen, Wash., March 10, and after discharging her cargo she was tied up at the wharf at the Hanlon shipyard, Oakland, where she is to have her engines installed. These will be twin 320 h. p. Bolinders, like the other vessels of this fleet. She is 230 feet in length with a beam of 42′ 5″ and depth of 24′ 9″. Her gross tonnage is 2,000. This is the fourth and last of this group of vessels which will be used in the trade with South America. Two will be used on the Pacific side and two on the Atlantic. These Grace vessels are intended to carry passengers as well as freight and for this reason mark an advance in motorships. The "Santa Christina" has just finished her equipment at the Hanlon yards and will soon sail for the south. The other two vessels are already in commission.

NEW MOTOR SCHOONER.

An auxiliary motor-driven schooner of 500 tons d. w. c. named the "Ichawna" has been launched at Waterhuizen, Holland, for the Neerlandia Mij of Rotterdam.

Italy As a Coming Great Motorship Building Country

A Fleet of Standardized 8,100 Tons d.w.c. Cargo Vessels Now Under Construction for the Societa Nazionale di Navigazione, of Which a Number Will Be Diesel-Driven Motorships

(Exclusive to Motorship.)

IN Italy there are other big motorships now building in addition to those described elsewhere in this issue, where we have given exclusive revelations concerning a Diesel-driven submarine-patrol-craft, motor-freighters and motor-tankers at present under construction at the newly enlarged motorship-building yard of the Fiat-San Giorgio, now under the control of the Gio Ansaldo & Co of Genoa. On these pages we are enabled to give further exclusive information regarding the great progress that the Italians have made in this direction since their country entered the war, and which we hope will stir America into prompt action whereby they will build similar ships. On behalf of the Societa Nazionale de Navigazione, of Genoa, the shipbuilding and engineering firm of Gio Ansaldo of the same city are building a fleet of standardized steel Diesel engined, and turbine and reciprocating driven cargo ships, and, together with their associates, the Fiat San Giorgio will complete in short time about twenty-two (22) craft of 8,100 tons d. w. c. each, and a regular stream of similar motorships each subsequent year. Apart from these Ansaldo's also are completing some Diesel-driven submarine-patrol vessels, also many steam-driven warships of all types, while another associated company, namely the Cantieri Savoia, of Cornigliano, Ligure, are constructing two auxiliary Diesel oil-engined sailing ships 6,000 tons d. w. c. each for the same owners.

Ansaldo's employ nearly 50,000 men in their various departments and lately increased their capital to 150,000,000 lire. In bringing forward this matter it is because we believe that we realize more deeply than the "man-in-the-street" the real seriousness of the submarine warfare and that it is some little way from being completely in hand. Although we believe it will be in hand soon, we must not take chances or hopes as facts, but must go ahead with merchant-ship and destroyer constructions just as if the submarines were doing twice the damage that they are. That is the only way to overcome the menace and win the war.

While this wholesale construction of motorships continues abroad, the Shipping Board officials at Washington seem to maintain an attitude of indifference to the many advantages of substituting or including oil-engined ships in the present constructional program.

In Italy the new motorship fleets are known as "Emergency Ships," and are regarded as the ideal all-round type of vessel to build at this critical period when the ocean is raked by enemy submarines, and when every ounce of ship-steel must be made to carry the absolute maximum amount of cargo, without having valuable space occupied by excessive fuel.

Furthermore, after the war the Diesel-driven vessels will represent highly desirable craft "that will compete" (to use the Italian shipowner's words) "with the most powerful foreign steamship lines." While we carry on this great war we must endeavor to prepare after-war trade, because the world will go on after the war is over, and all of us have to live and to trade as of yore, also the war cannot last for ever. The first thing is to win the war, but if our plans enable us simultaneously to prepare for peace conditions, so much better it will be for America. This is a logical and efficient course to take. Why aren't we taking it?

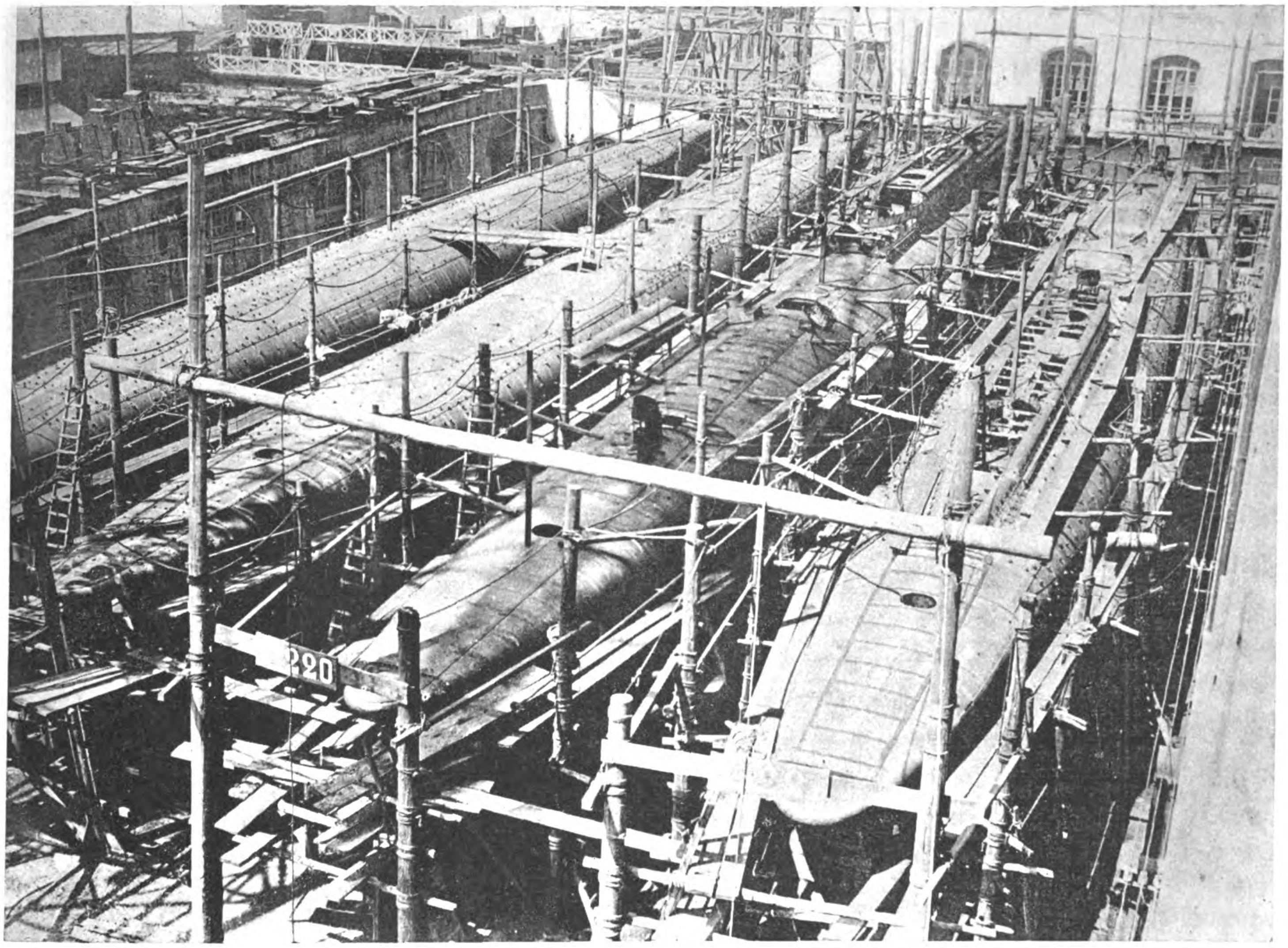
As we have just mentioned, the officials at Washington responsible for the building of America's great merchant marine would seem not to seriously regard motorships as an immediate and vital war necessity. What is the present attitude in Italy? At the last extraordinary meeting of the Societa Nazionale di Navigazione the board of directors issued a statement from which we cull the following extracts, viz.:

"The great fleet of Italy of tomorrow must intrinsically be the glory of Italian industrial achievement. It must be the price and inspiration of the Italian working man. In this sense, its development will contribute to solving the problem of labor, which looms up so seriously with all the importance of that great social question. The renaissance of our shipbuilding industry will be synonymous with insuring work in Italy to hundreds of thousands of our laborers and artisans.

"This national fleet, however, should include a fleet of coastwise ships consisting of motor-auxiliary sailing-vessels and motor-driven ships for commerce within the Mediterranean Sea. Italy must revive the splendid traditions, still slumbering, of its master ship carpenters who populated its river mouths with innumerable ship yards. With the benefits of our assistance and technical direction, they will soon once again supply Italy with the ships necessary to create a great coastwise marine.

"The eight steel vessels now building do not cover our entire plans. We shall immediately follow these with eight more new steel vessels of the same class of 8,100 tons each. (Others since have been ordered.—Editor). In addition to the foregoing ships, we are having built a number of sailing vessels of 2,000 tons each, provided with Diesel engines of 400 h. p. each. A large number of these oil engines are already in process of construction, some in the Department of Internal Combustion Engines of the Alsaldo Company, some in the yards of the Cantieri Savoia at Cornigliano Ligure, and others in the yards of the Fiat San Giorgio Company.

"The twenty-two ways of these shipyards, with the assistance of the large associated engineering and steel works, insuring a constant production of the requisite materials, will see, as soon as the feverish activity of the war work is over, the building of powerful trans-Atlantic liners capable of competing from the standpoint of safety, careful and modernized construction, ton-



FOUR DIESEL-DRIVEN MINE-LAYING SUBMARINES UNDER CONSTRUCTION AT THE ANSALDO SHIPYARD. THEY ARE NOW IN SERVICE

nage and speed, with the largest and most famous ocean greyhounds. This will be in addition to our program, before set forth, for the early and rapidly continuing launching and equipping of large, substantial freighters.

"These problems require the interest and support of our Government, which we are sure will know how to second our efforts with all due solicitude. Private initiative is a powerful asset, but it cannot do all. So that it shall not remain sterile or that private efforts shall not be made in vain, it must be backed up by a generous governmental foresight. We have full confidence in receiving this measure of assistance from our Government."

We would draw attention to their reference to the necessity of Government support and the same is needed for motorships and oil-engine construction in the U. S. A. today. This Italian shipowning company recently increased its capital to 60,000,000 lire, and at the same time issued bonds to the total value of 50,000,000 lire. They have leased a large new municipal pier at Philadelphia, Pa., where their motorships will dock.

Our cover picture shows a ship of their new standardized type of Diesel motorships under construction. The dimensions of this and sister vessels are as follows:

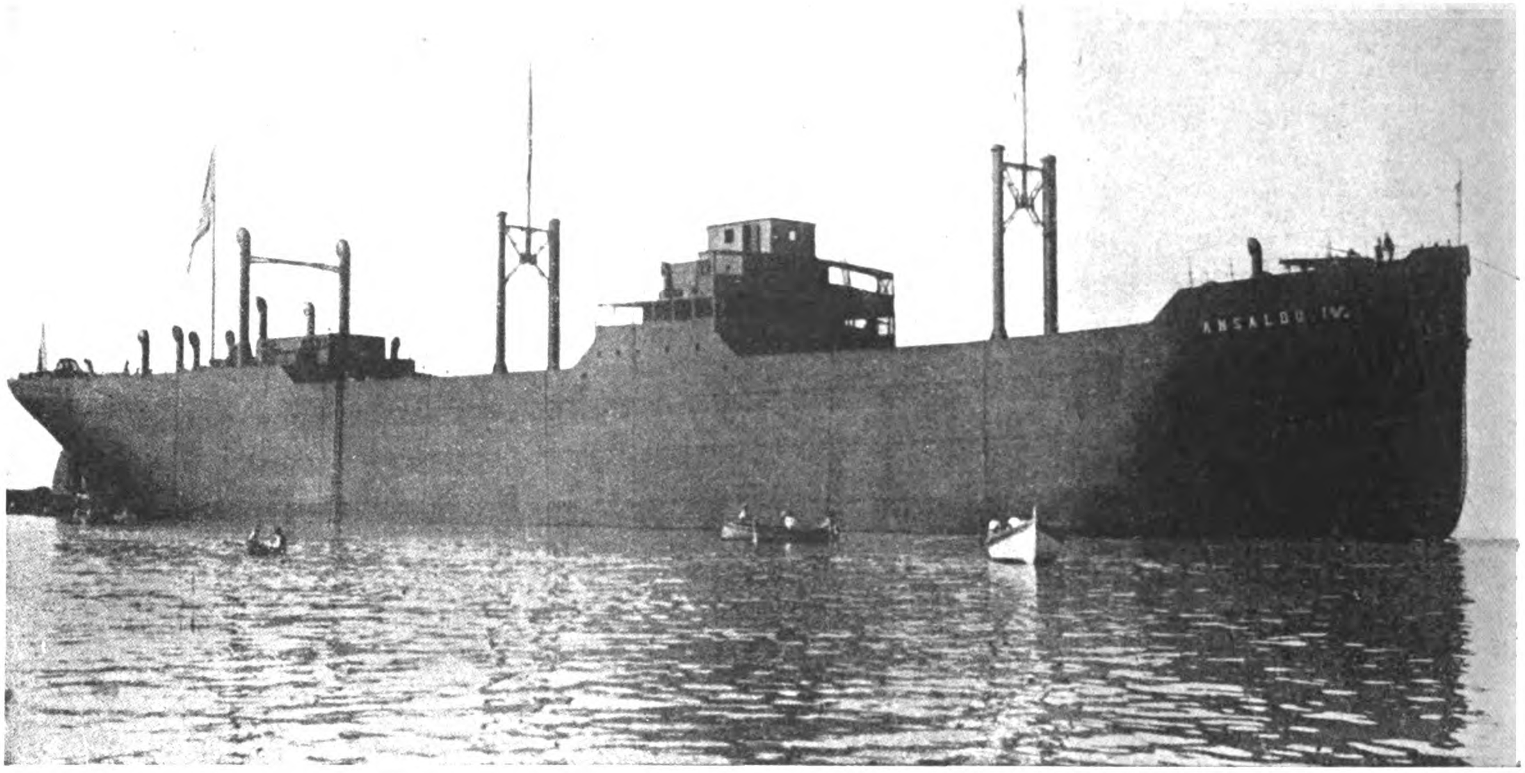
Length o. a., 119.85 meters (about 390 ft.).
Length b. p., 114.92 metres.
Breadth, 15.78 metres (about 52 ft.).
Molded depth, 9.47 metres.
Draught, 7.42 metres.
Deadweight capacity, 8,100 tons.
Speed, 11½ knots.
Power, 2,000 shaft h. p. (about 3,000 steam i. h. p.).
Type of engines, Ansaldo-Sulzer two-cycle Diesel.

The ships building by the Fiat-San Giorgio are of very similar size, but differ slightly in design, and will have Diesel engines of Fiat design.

America should take steps to keep pace with this motorship construction, for Italian shipping will be found a formidable business competitor after the war. In 1917 fourteen new Italian navigation societies with a combined capital of 225,350,000 lire were formed, and increases of capital of existing shipowning companies amounted to 265,400,000 lire. New shipyards were built with a total capital of 55,500,000 lire, and two shipyards increased their capital by 20,500,000 representing a total new capital of 566,750,000 lire. In addition to the above Ansaldo & Co. have since increased their capital to 100,000,000 lire, and the Fiat-San Giorgio have issued new shares to the value of 12,000,000.

The industrial war efficiency of Italy has increased thirty times over within two and a half years, according to Dr. Albert Dallolio, Minister of Arms and Munitions.

"We were able to turn over three hundred cannons during the month of November to replace those lost to the enemy in October" he said. "An idea of what has been accomplished may be gathered from the fact that whereas previous to Italy's entrance into the war we had about 125 incompletely equipped factories, employing 125,000 workmen, today we have 3,500 factories going and will soon have 4,000, employing over 700,000 workmen, of whom 160,000 are women and 45,000 are boys. Of these 3,500 factories, 1,750 are classified as auxiliary and 1,800 as minor shops."



EVEN UNDER WAR CONDITIONS ITALY IS ABLE TO BUILD DIESEL-DRIVEN MOTOR VESSELS RAPIDLY, AND WHAT LITTLE ITALY CAN DO, AMERICA CAN ALSO DO. THE ILLUSTRATION SHOWS THE FIRST OF THE ANSALDO STANDARDIZED SHIPS BUILT FOR THE SOCIETA NAZIONALE DI NAVIGAZIONE

Skandia Operations and Sales

AMONG recent orders placed with the Skandia Pacific Oil Engine Company, of Oakland, Cal., are those for two 350 b. h. p. engines which are now being installed at San Francisco aboard the motor schooner "Lassen," built at the Matthews shipyard at Hoquiam, Wash., and for four 500 b. h. p. to the order of the General Fireproofing Company, New York, which are to be placed on vessels on the East Coast. Four more of the 500 b. h. p. size are on order for the Anderson Shipbuilding corporation of Seattle. The 350 and 500 b. h. p. Skandias are of the open base type with a separate scavenging pump fitted to the end of the engine. With this open crank type of engine the crank pin bearings are exposed and the engineers will be able to take care of and notice the warm bearings long before this would be discovered on the closed type engine. The engines for hulls 11 and 12, built by the Puget Sound Bridge & Dredging Company, Seattle, which are also of the 350 b. h. p. size are about ready for shipment.

Two engines of the 240 b. h. p. size have just been delivered from the factory to a motorship building at Savannah, Ga., and two more of the same size are to follow. The shops are also busy with four 240 b. h. p. engines for the Matthews Shipbuilding Company, Hoquiam, Wash., four of the same size for the McAteer Shipbuilding Company, Seattle, six of the same size for the Martinolitch Shipbuilding Company, and four for the Sandstrom Shipbuilding Company, all of Seattle.

Several orders have been placed for smaller engines among these being a number of 55 and 120 b. h. p. engines for vessels building in Eastern Canada, several of the 38 and 55 b. h. p. engines for fishing vessels in Southern California, four 180 b. h. p. engines for the vessels built in the Philippines, two 140 b. h. p. engines for a motorship in New York. Several of the 100 b. h. p. engines of the stationary type are being built for use aboard gold dredges in Alaska.

This company is also getting out a direct-connected generating set of 6 KW capacity driven by a 9 h. p. Skandia engine for electric lighting aboard motorships. It is also enlarging its shops for the building of the Werkspoor Diesel. Several large machines have been installed, including one 42" lathe, one 46" lathe, one 60" lathe and one 66" lathe besides numerous automatic tools.

NEW PETERSON MOTOR VESSEL.

The Henry Peterson, Inc., of San Francisco, has just received from the builders George Kneass & Co., of San Francisco, a new launch which is to be used in carrying passengers. She is 64'x18' and powered with a 110 h. p. Union Gas engine. There are steel bulkheads as required by the law, where passengers are carried, and forecastle accommodations for six men. Another launch was launched for this company by Kneass this month, which with the pilot house control may be operated by one man. This boat will have accommodations for thirty or forty passengers.

MOTORSHIPS BRING VALUABLE CARGOES.

As an illustration of the good work being done by motorships it may be mentioned that the Danish motorship "Chile" recently arrived in San Francisco from Calcutta with enough jute in bales and bags to relieve the immediate shortage in the state of California. In her cargo she brought over 9,000 bales of jute and 2,000 bales of jute cuttings as well as 500 bales of jute cuttings. Besides these she brought over 300,000 gunny sacks already manufactured. As an example of the profit that shipping is making at the present high cost of freights it may be said that every one of those jute bags when they were unloaded on the wharf at San Francisco carried a charge of almost six cents for freight charges across the ocean. Another motorship to bring war help was the "La Merced," which arrived on the first of March with 1,500 tons of wheat from Australia.

SLIGHT ACCIDENT TO "ERRIS."

The American Asiatic Company which has chartered the motorship "Erris," belonging to the Erris Motorship Company of Portland, say that the reports that the vessel had met with serious disaster on her way from San Francisco to Kobe, Japan, were erroneous. The "Erris" while proceeding to her destination blew out a cylinder head and made her way to Honolulu to have it repaired. She was delayed scarcely two days at Honolulu and then continued her trip. As this is one of the first motorships that the American Asiatic Company has employed the news that she had put into Honolulu in distress worried them until the truth was learned.

A concrete shipyard has been laid down at Aberdeen, Scotland, by James Scott & Son of that city. The site covers 7,130 square yards.

East Asiatic Company Abandons Steam for Diesel Power

(In publishing the following article, which was written specially for "Motorship" by the East Asiatic Co. of Copenhagen under instructions from Counsellor-of-State H. N. Andersen, we do so verbatim without any sub-editing whatever, preferring our readers to have direct the exact belief of this important Danish ship-owning concern, and we draw particular attention to their last paragraph.—Editor).

COUNSELLOR OF STATE H. N. ANDERSEN is the chief managing director of The East Asiatic Company, Limited, of Copenhagen, the Danish mercantile and shipping concern who were the first to employ the Diesel motor in large ocean-going liners, and the fact which will prove of most interest to readers of the "Motorship" in Mr. Andersen's career is his efforts, as pioneer, in connection with the utilization of the Diesel motor for navigation purposes on the high seas. The first of this type of motor-vessel which was ordered to be built by a Danish yard for The East Asiatic Company early in 1912 was the M. S. "Selandia," a twin-screw ship of 7,400 tons d. w. driven by two principal motors of 1,250 h. p. each, with two subsidiary motors for working the electric machinery used in loading and discharging cargo, the pumps, steering-gear, light and refrigerating machinery, ventilators, etc. The same year two further motor-vessels of a like size were completed, and by 1915 the company's fleet of motor-vessels of increasing sizes—up to 10,000 tons—had already risen to 114,611 tons d. w. The results obtained having proved from the first to be so favorable, the company decided to accelerate the expansion of its ocean-going fleet of motorships, and at the same time **to eliminate its steam-liners** —which at that moment totalled 72,780 tons d. w.—and have them formed into a separate company, the steamship company "Orient," **and in the future only to employ motorships on its over-sea services,** consisting of the Siam Line, the China and Japan Line, the West India Line, the South Africa Line, and the two Pacific Lines (the coasts of North and South America), and the Australia Line.

The exposé given below of the considerations which prompted the East Asiatic Company to attempt the building of ocean-going motorships are chiefly taken from the annual reports of the company for the years 1912 to 1916.

Whereas in a steam-engine about three-fourths of the heat originating from the fuel is lost, the fuel, in a Diesel motor, acts direct on the machinery, which of course means a large saving, and the latter becomes even greater by the use of oil instead of coal. As coal bunkers are dispensed with, the carrying capacity of the ship is enlarged, and this is further increased by the difference in weight between coal and oil. A motorship can easily in its ballast tanks carry sufficient oil for the whole voyage, by which calling at ports for coaling purposes as in the case of the steam vessel—and the waste of time occasioned—is unnecessary. The heating of the vessel from the boilers is also done away with, which particularly in the tropics is of great consequence to the cargo, and at the same time the danger of spontaneous ignition is considerably reduced.

The whole question was discussed by the company with Messrs. Burmeister & Wain, the Copenhagen shipbuilders, and taken under very careful consideration, and each step forward was watched by the company's experts with the greatest care. Amongst the hindrances first met with, the difficulty in getting the machinery to reverse proved the greatest. But this also was overcome in the end, and the company began negotiations with Messrs. Burmeister & Wain for the building of a motorship of 400 tons. But during the discussions Mr. Andersen raised the question that if the principle permitted 400 tons why not 1,000 tons? and if it was feasible for a ship of 1,000 tons why not 3,000 tons? Yes, why not? and in the end it was decided to build three Diesel motor-vessels of 7,000 tons each with motors of the 4-cycle type as a distinct feature. At the same time Mr. Andersen, clearly seeing the possibilities of the industry, closed a number of advantageous oil contracts likely to cover the requirements of the company over a period of years.

The correctness of these considerations have been fully confirmed by years, while the new improvements continually added to the motors from experience gained, have brought them successfully through the initial difficulties and that period of trial from which all new experiments are liable to suffer.

If the M. S. "Selandia" had been fitted with steam engines with corresponding power to that of her Diesel oil-engines, her coal consumption would have averaged about 40 tons in 24 hours, whereas the oil consumption on her maiden voyages averaged 9 tons per 24 hours, and has since been gradually reduced to 8 tons. The design of the Diesel engines in the motor-vessels now building to the order of the company has been improved and a further reduction in the oil consumption is expected.

Owing to the high temperature prevailing in the stokeholds of steamers in the tropics, particularly in the Red Sea, difficulties are usually experienced—and often with a greater consumption of coal—in keeping up normal steam on the boilers, followed by decrease in speed. In motorships these circumstances are reversed. The thick oil used for the Diesel-engine becomes thinner under the influnce of the tropical heat. This improves the automatic injection, whereby the consumption of oil is reduced while the speed increases.

One advantage in the Diesel marine-engine as compared with the marine steam-engine is that one or more of the cylinders, all of which work independently of each other, can in case of need be instantaneously disconnected without the stoppage of the engines for that purpose. There have been no difficulties in the tropics in keeping the engines cooled by means of sea or river water. A steamship, especially after a stay of several days in port, requires from 12 to 24 hours for raising steam and making the engines ready to start, whereas the marine oil-engine is ready to start at a few minutes notice.

The marine boiler, including the piping, etc., is a source of considerable expenditure for maintenance. The boilers, when a steamship grows older, are its weak point, and usually require extensive repairs and renewals. The same applies to those parts of the vessel surrounding the boiler space, such as the bottom and sides of the ship, which are comparatively soon affected by corrosion caused by the heat radiating from the boilers as well as by the moisture contained in the coals, thereby affecting the vessel's sides in places where coal is bunkered. This drawback is dispensed with in motor-vessels, where no boilers are required. The bottom tanks, which in a steamship are generally used for ballast, usually sea-water, causing corrosion, are in motor-vessels utilized for storing fuel-oil which prevents corrosion, a fact of special importance in places difficult of access for general maintenance.

Judging from the data to hand it appears that the fixed as well as the working parts of the Diesel marine-engine, have as long a life as those of the marine steam-engine, and also that repairs and renewals to its working parts will not exceed those to the corresponding parts of the steam-engine.

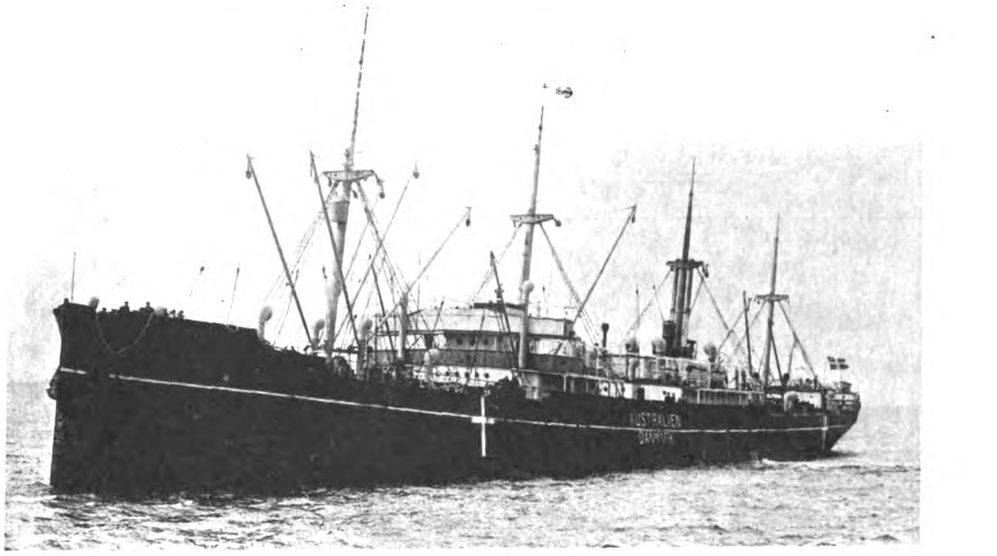
The smaller weight of the Diesel engine and the fuel oil carried in motor vessels, as compared with the weight of the engine and coal in steamships, has resulted in larger freight receipts owing to the increased carrying capacity.

As an example of the efficiency of this type of vessel it may be stated that the M. S. "Siam" of 10,000 tons, completed in 1913, sailed from Copenhagen to Japan and back on its first voyage, then across the Atlantic round Cape Horn to San Francisco, during which second voyage the motors ran 42 days and nights without stopping, which, as far as is known, has never been accomplished by a mechanically driven vessel. (Two of the Anglo-Saxon Petroleum Company's motorships have made non-stop voyages of 44 and 42 days and nights respectively.—Editor). From San Francisco she returned via Vladivostok and Suez to Copenhagen, and the "Siam" is therefore the first motorship which has carried out the circumnavigation of the globe. She covered a total distance of 62,600 miles.

A large number of motor vessels after the Danish system are already in service for various owners, and the building of motorships in accordance with that system have been taken up in various countries, such as England, Germany, Norway, Sweden, etc.

From the fact that The East Asiatic Co. at the moment possess a fleet of 15 Diesel motorships totalling about 120,000 tons d. w., and have contracted for a further 250,000 tons d. w. of Diesel motor vessels up to 14,000 tons d. w. each to be delivered as quickly as circumstances permit, it will be evident that the company, who is at the present contemplating the ordering of further Diesel motorships, place the greatest confidence in the possibilities and future development of this industry.

THE EAST ASIATIC COMPANY.



MOTORSHIP "AUSTRALIEN"

THE "Australien" is one of a fleet of motor-vessels which are to ply the waters of the Pacific from Seattle, Wash., to the East Indies. She is owned by the East Asiatic Company who have many vessels of this size and larger in operation about the world. The "Australien" was built in 1915 by Burmeister & Wain and also engined by them in Copenhagen, Denmark, and is now under charter to the India Pacific Line of London, England. She is a twin screw vessel, 410′ long, 55′ beam and 35′ of moulded depth.

Propelling power is generated by twin 3,100 b. h. p. 6-cylinder 4-cycle type Burmeister & Wain Diesel engines, giving her a speed of 11 knots at 116 r. p. m. She is electrically equipped throughout, power being generated by means of three 60 b. h. p. auxiliary engines of the same make and type as the main engines. These supply electricity for lighting and for the deck machinery and windlasses and power for the fuel and water pumps. A steam oil-fired donkey boiler supplies heat for the ship.

The New Armstrong-Whitworth Marine Diesel Engine

A NEW four-cycle marine Diesel engine recently was put under test at the Elswick Works (England) of Sir W. G. Armstrong Whitworth & Co., Ltd., and after a total of nine hours "tuning-up," carried through successfully a non-stop trial of 72 hours duration, or equivalent to over 1,000 miles running of the ship. This may be considered excellent for the first of a set of entirely new designs, which this shipbuilding company are producing.

This information was given by Mr. P. N. Everett, A. M. I. C. E., their designer (internal-combustion-engine department) in a lecture before the Newcastle branch of the Association of Engineering & Shipbuilding Draughtsmen.

After dealing with many other mechanical problems presented by the internal-combustion-engine, Mr. Everett said that the type of engine, which appeared at present to offer the most promising outlook for marine work, being some form of two-stroke Diesel, it would be instructive to compare that with the triple-expansion steam set now in common use. The comparison was not made with a view to showing either to be superior, but to show the nature of the problem involved. He instanced a steam set indicating 2,180 h. p. with engines 25 in. 41 in. 66 in. by 45 in., 180 lb. sq. in. boiler pressure, 80 r. p. m.; boilers, two of 15 ft. 6 in. diam., 11 ft. 9 in. long; total heating surface, 6,100 sq. ft., and said the shaft horsepower of such a set would be about 1,980. Assuming the equivalent Diesel set to have six single-acting cylinders, 330 b. h. p. per cylinder, that would require cylinders, 24 in. diam. by 43 in. stroke by 100 r. p. m.

The cylinder pressures would be:

	Steam set	Diesel
Maximum pressure in cylinder..	180 lb. sq. in.	500 lb. sq. in.
Maximum Load on piston......	394 tons	101 tons
Mean eff. pressure in cylinder...	80 lb. sq. in.	100 lb. s. in.
Ratio max. to mean pressure...	225:1	5:1

The cylinder temperatures would be: Steam to high-pressure cylinder, 180 lb. sq. in.; temperature, 380° F., and exhaust from high-pressure cylinder, 60 lb. sq. in., 307° F.; high-pressure and low-pressure cylinders would have an equal range, approximately.

Diesel engine: Temperature of air entering cylinders, 60° F.; temperature at beginning of compression, 120°; temperature at end of compression, 1,000°; temperature at end of combustion, 2,300°; temperature at end of expansion 1,200°, and temperature in exhaust pipe, 700°. The three penultimate temperatures were calculated from the indicator diagram; but it was most likely that the maximum temperature actually attained in the cylinder was very much higher, probably nearly 3,000°. The melting point of cast-iron was about 2,000° F., but fortunately, these enormous temperatures were prevented from reaching the cylinder walls by some action on the adjoining layer of gas.

In the sets under consideration, the steam set had six furnaces, and the Diesel six cylinders. About one-third of the fuel stoked on to the boiler-grate was burned in the small cylinders of the internal-combustion engine, but combustion took place in about one-tenth of the time. The heating surface per furnace for the boiler was about 1,020 sq. ft. The surface per cylinder enclosing the combustion space was about 7.8 sq. ft., and the total cylinder surface for carrying away the heat was about 30 sq. ft., i. e., less than one thirty-third of the surface available for heat transfer in the boiler. These figures gave some idea of the tremendous intensity of the combustion in the cylinder of an internal-combustion-engine.

These facts were sufficient to show the absolute necessity of specially selected materials, special arrangements for lubrication, and exceeding great care in design, manufacture and operation. In a steam set, fuel was supplied by the shovelful at the pleasure of a fireman. In the Diesel set it was fed mechanically in definitely measured quantities—about 0.025 of a lb. in the case under consideration—and any great increase in the amount might, with an extra supply of air, blow the cylinder-cover off. That question of independence of the human element in fuel feeding would appeal to the seagoing engineer, judging by the condition most firemen were said to be in when leaving port.

Regarding the marine use of producer-gas engines, he said the scope was too large for the limits of his paper.

Although we had not as yet a home (England) supply of suitable fuel, a boat trading with a country with an oil supply could fuel there, taking in sufficient for the round journey, and still devote less space to bunkers than in the present steamship. The war had, however, surely taught us not to develop our necessities so as to be dependent on any other nation, and it appeared obvious, therefore, that either an oil engine running on tar-oil or a gas-engine and producer must ultimately come, even for marine propulsion.

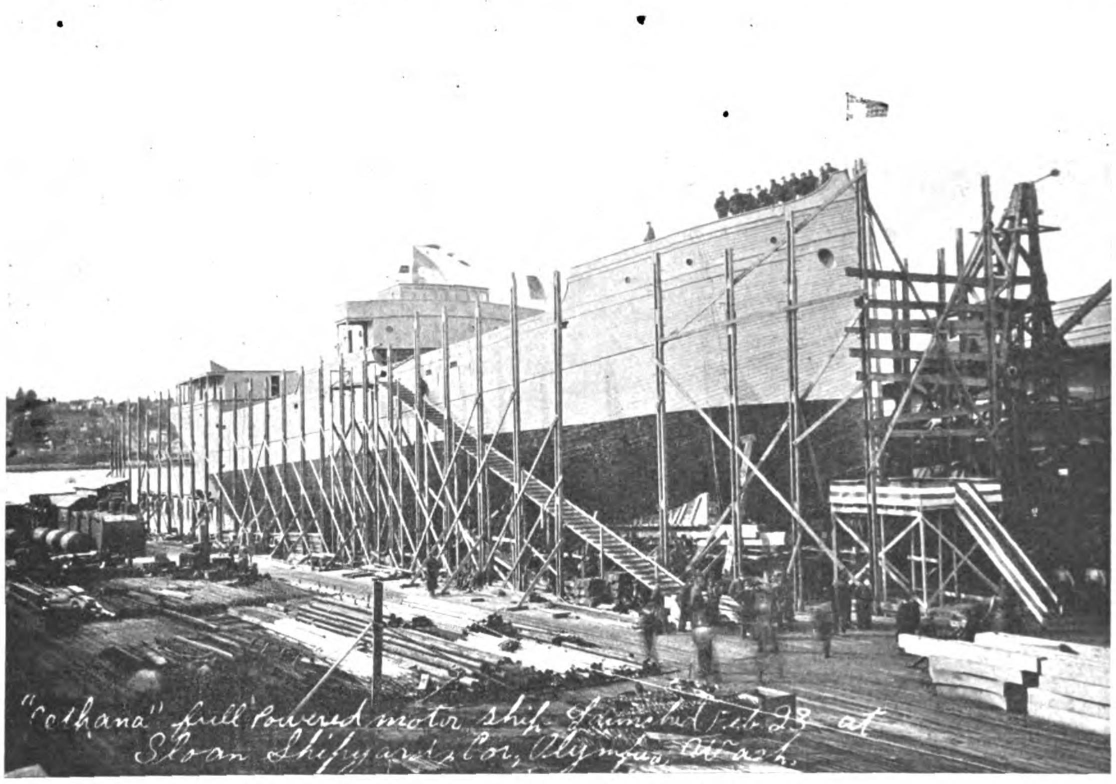
Meanwhile, the present Diesel-engine was being severely tested, and, to give it a fair chance, the naval-architect should see that the seating was amply strong. Many cases of crankshaft fracture and other failures had been directly traced to excessive vibration due to weak seats. Furthermore care must be exercised in installing the engine in the boat, it being necessary to rebed the crankshaft and the main bearings after the bedplate was lined up and before the remainder of the engine was assembled.

Mr. Everett gave a few average weights for various classes of engines, remarking that the comparison was no less startling than that of sizes.

Description.	Weight lbs. per b. h. p.
Triple-expansion steam-engine for cargo boat (no boilers or auxiliaries)	130
Triple-expansion steam-engine (including boilers and auxiliaries)	450
Diesel engine for cargo boat (no auxiliaries)......	250
Diesel engine for cargo boat (with all auxiliaries)..	400
Turbines for cross-Channel boat (with boilers and auxiliaries)	200
Diesel engines for submarines	50
Steam reciprocating-engines for destroyers	35
Petrol engines for motor cars	16
Petrol engines for racing cars	7½
Aero engines	2½

Concluding, he stated that an alteration in principle of the internal-combustion-engine, which had received considerable attention for some time without much show of success, was the application of the turbine principle; if ever that was made a practical success great strides would have been made. As regarded detail improvements, the following were the obvious directions in which to look: Increase in power per cylinder; reduction of the losses of the heat balance; reduction of the ratio of maximum pressure to mean pressure in the cylinder, which ratio was high for the internal-combustion-engine; and special improvements designed to make an engine more suitable for a particular service.

First McIntosh & Seymour Marine Diesel Installation



MOTORSHIP "CETHANA" JUST PREVIOUS TO HER LAUNCHING

THE first of the four full-powered ocean-going wooden motorships, being built at the yards of the Sloan Shipyards Corporation for the Australian Government, the "Cethana," was launched February 23, and a sister ship, the "Culburro," was launched March 12. These ships along with the remaining two mark the first marine installations of the McIntosh & Seymour Diesel engine. All of them are classified under British Lloyds. We show the "Cethana" just before the launching

Each of these vessels are 280′ o. a. by 46′ beam with a moulded depth of 24′, and have a d. w. c. for 3,200 tons. They are powered with two 500 b. h. p. 6-cylinder 4-cycle McIntosh & Seymour Diesel engines, giving 1,300 i. h. p. to the hull. The auxiliary equipment will be steam driven. The main engines of the "Cethana" are already being installed and the builders expect to give the ship her official trials about the first of May.

DIESEL ENGINE CONSTRUCTION IN SWITZERLAND.

Nearly Half-a-Million Brake-Horse-Power in Sulzer Motors Completed.

Since they first commenced Diesel-engine construction Sulzer Freres of Winterthur, Switzerland, together with their various constructional licensees in other countries have constructed almost half-a-million brake-horse-power in marine and stationary sets, of which 165,250 b. h. p. were for merchant ship and submarine purposes.

The total number of Diesel engines may be divided as follows:

MARINE ENGINES (Two Cycle).
Merchant and Submarine-Type.

Sulzer Bros.	90,550 b. h. p.
Foreign licensees	74,700 b. h. p.
Total	165,250 b. h. p.

STATIONARY ENGINES.

	Four-Cycle.	Two-Cycle.
Sulzer Bros.	217,470 b. h. p.	81,000 b. h. p.
Foreign Licensees	20,600 b. h. p.	700 b. h. p.
	238,070 b. h. p.	81,600 b. h. p.
Total		319,770 b. h. p.
Grand Total—485,020 brake-horse-power.		

Perhaps a better idea of what this means will be obtained when we mention that had all these Diesel engines been of the merchant-marine type they would have represented propelling power for about 161 ships of 10,000 tons dead-weight-capacity and of 12 knots speed. At a later date "Motorship" will give some interesting details and illustrations concerning the great things in Diesel engine work that have been accomplished since the war by this big Swiss engineering concern, special article now being under preparation. From an engineering standpoint, as well as from mercantile and naval aspects this article will be unusually valuable and should do much to accelerate domestic manufacture and adoption of marine Diesel-type heavy-oil engines. In various countries about a dozen constructional licenses have been granted by Sulzer.

Ferro-Concrete Ships

By T. J. GUERRITE, Ing. E. C. P., M. Soc. Ing. Civ. (France), Councillor of the French Board of Trade

To judge by the surprise evinced in the daily papers when the first reports were published a few months ago of the great impetus given by the war to ferro-concrete shipbuilding activities, one might have imagined that there was something startlingly new in the idea, and much nonsense was printed at the time, under big head lines. And still the last few years have merely seen the development of activities dating from many years back. It is, in fact, a curious coincidence that it was the author's privilege to deliver a paper entitled "Ferro-Concrete as applied to Floating Structures" in the year 1908 before one of the Newcastle building trades associations, the matter of which formed the basis of many of the articles which were published on the subject during the last few months. The conclusions of that paper ran as follows: "The particulars and illustrations given seem sufficient to indicate that ferro-concrete has to be taken into account as a ship building material, owing to its small initial cost and the absence of upkeep. The author is far from thinking that super-dreadnoughts are likely to be built in ferro-concrete, at any rate for the present, but in smaller and commercial craft and for special purposes, he is convinced that it will be used more and more. The question of weight is not so paramount as it may seem at first when to the weight of the hull is added that of all fittings and cargo, which remain the same both for ferro-concrete and for steel ships." The recent strides made in this mode of construction seem to justify those prognostics.

So much has been written lately on the general principles and history of ferro-concrete as applied to shipbuilding that it seems unnecessary to recite once more these facts and it is proposed therefore to enter at once into more precise details.

I.—Material of Construction.

This is evidently a fundamental question and we shall consider in turn the two components of a ferro-concrete hull, viz., concrete and steel.

(a) The concrete employed must be non-porous, so as to prevent leaking and the steel being attacked by sea water, it must also be strong so as to resist the heavy compressive stresses to which, in parts, it is submitted and it should be as light as possible. The last named condition is unfortunately difficult to fulfill at the same time as the other two, and the latter are of greater importance. Light aggregates such as pumice stone, ashes, coke breeze, which are used in land work for making light concrete, are too porous; they would absorb a large weight of water and would give too weak a concrete; they cannot be utilized for ships. Clean shingle, of a flinty nature, is a suitable material, and would give a concrete slightly lighter in weight than crushed granite or whinstone. Gravel originating from sandstone must be subject to careful scrutiny before being allowed for ship construction as it is sometimes of a somewhat porous and friable nature and might prove a source of weakness both as regards porosity and crushing strength. Crushed granite and, generally speaking, crushed stone of a hard and impervious nature, are perhaps to be given the preference, notwithstanding their somewhat heavier weight. The same physical qualities are essential for the sand. Of the cement itself, little need be said, years of experience have proved that if it is up to British Standard Specification it will prove suitable for sea work.

With such constituents and it being understood that fresh water only should be used both for making the concrete and washing the aggregate if necessary, a suitable concrete will be made if proper proportions are adopted and the materials are properly mixed. In determining proportions great care should be taken that the aggregate be properly graded, that is, it should contain stones of various sizes, the smaller ones helping to fill the voids between the larger, and the same applies to the sand which should be a mixture of sharp particles and of finer sand going down almost to dust. The proportions of voids both in the aggregate and in the sand should be carefully determined and there should be a good excess of cement paste over the quantity strictly required to fill the voids in the sand, and similarly a good excess of mortar (i. e., sand and cement paste) over that required to fill the voids in the aggregate. As previously mentioned crushed stone will be used often as an aggregate, and it so happens, that it contains as a rule a considerably greater proportion of voids than shingle, and this may result in porousness in the concrete unless proper attention is paid. The question of voids and of porousness is of very great importance, but forms in itself a vast subject. The author had the opportunity of reading a paper quite recently before the Society of Engineers on this subject, to which he would refer those interested; but it appears to him that its importance is such that it should be particularly emphasized tonight when dealing with concrete for ship construction.

From practical considerations the author does not deem it advisable to allow for a lesser thickness of concrete than 3 inches for the sides and bottom of a vessel, except in special circumstances, and however much one might like to see it reduced so as to lighten the structure. The figure of 2.8 inches is mentioned as a minimum in the preliminary rules for ferro-concrete ships issued by the Danish Government, but except for very small craft 3 inches will prove in practice to be the minimum. The scantlings of frames, stringers, etc., are also reduced as much as possible owing to the same desire to reduce the weight, and the thickness may be taken at 2½ inches and even less in some cases but great care will have to be exercised to insure proper covering of the bars by the concrete and proper bond between them. It is therefore necessary to use an aggregate of small size, which will be worked easily in so restricted a space and among a comparatively great number of steel rods. Some engineers went as far as to suggest the total abandonment of aggregate, and the replacement of concrete by a mere sand and cement mortar. But the method has been proved to be unsatisfactory in ordinary ferro-concrete work and the same would apply to ship construction. A happy medium is to be recommended and the author's firm have ultimately adopted the following mixture for their designs:

Aggregate, being a well graded mixture of stones from ⅝ inch size down to ¼ inch and free from sand, 27 cubic feet.

Sand, from ⅛ inch downward, the grains being also of well graded sizes, 13½ cubic feet.

Cement, 8½ cwts.

Such a concrete may be termed a 1.6: 2: 4 concrete.

The above proportions apply as long as the percentage of voids in the aggregate does not exceed 50 per cent. If it exceeds 50 per cent. a corresponding quantity of sand and cement is added.

It has been suggested by various engineers that a much poorer concrete might be used with safety, say a 1:2:4 or 1.2:2:4 concrete, if a good rich rendering were applied later on the external surface of the sides and bottoms. But such a rendering would be extremely difficult to make properly, especially when nearing the bow and stern, and with the hard wear and tear to which ships are submitted it would soon come away in patches.

In order to obviate the difficulty of making a proper rendering other engineers have suggested to use a comparatively poor concrete, say 1: 2: 4 or 1.2: 2:4 for the inner 2 or 3 inches of the walls and bottom and to place carefully at the same time in the mould a rich mortar (1 of cement and 1 of sand) to form the external inch. The author's experience leads him to deprecate the juxtaposition of two concretes of so different a richness in cement, and unless supervision of the most constant and strict nature is exercised during erection he doubts the efficiency of the method. All told it seems decidedly better to adopt a uniformly rich mixture, such as mentioned above, which will give a very good face to the concrete when moulds are struck off, prove quite impervious, afford a high crushing strength, and be easily worked into the moulds.

(b) Steel.—We turn now to the other component element of the structure, viz., the steel. The general tendency in ferro-concrete practice has been to utilize as reinforcing material mild steel in the form of ordinary round bars, with an ultimate tensile strength of from 28 to 32 tons per square inch, an elastic limit varying from 30,000 to 40,000 lbs. per square inch and an elongation of at least 20 per cent on a length of 8 times the diameter. Such steel was used in the construction of most of the numerous river and canal barges and pontoons built in ferro-concrete during the last fifteen years, and it was natural to look to the same material again, when great impetus was given lately to the construction of sea craft in ferro-concrete by the difficulty of procuring all the steel plates required for commercial craft. Mild steel was therefore used and will be used in many ships notwithstanding the difficulty one meets in obtaining it at present. Shell discard steel has been put forward as a substitute, mostly with the object of avoiding the use of mild steel, seeing that it is more easily obtainable than the latter at present, but not owing to its special physical properties. For the present, apparently, Lloyd's Register are not prepared to sanction its use. One of their surveyors, Mr. Bernard J. Ives, has stated that, "As the ferro-concrete ship is only in its experimental stage and as practically no experience has been obtained so far from actual seagoing conditions, a wise precaution at the present time is to eliminate any doubtful factors and the steel should therefore be of the quality used in ordinary shipbuilding work."

It is a question, however, whether the disadvantages attaching to the use of shell discard steel, if one looks at the question from the usual standpoint of steel ship construction, would not be more than compensated by certain advantages it would present from a ferro-concrete point of view. These advantages are somewhat similar to those attaching to the use of a special quality of steel, which the author's firm, after careful consideration of the matter during the last two years, are now specifying for ferro-concrete ship construction. It may be stated at the outset that the problems of ferro-concrete construction as applied to naval architecture are very different from its problems as applied to land work. Firstly, and for obvious reasons, it is desirable to reduce the weight of the hull, and consequently of all the scantlings, as much as possible, consistent with good work. It becomes, therefore, of great interest to use for the reinforcement steel possessing a higher elastic limit than mild steel, the elastic limit being an all important factor in ferro-concrete work. Not only does this obviously tend to reduce the weight of steel required and consequently the weight of the hull, but also the same cover of concrete over the reinforcing rods can be maintained while reducing the thickness of the members by the same amount as the diameters of the high elastic limit steel rods are smaller than those of the mild steel bars which would otherwise be used, thus securing an indirect but very important saving in the weight of the hull.

A second point which deserves very careful consideration is that of the transmission of the stresses in the steel from bar to bar. As is well known, in ferro-concrete construction the bars are not tied together, nor welded, nor connected by coupling boxes (except in very special circumstances). Stresses are transmitted from bar to bar through the agency of the adhesion grip of the concrete surrounding them, the bars overlapping each other. Their ends are usually fishtailed or hooked with a view to helping further the adhesion. In ordinary ferro-concrete work the mass of concrete surrounding the rods is comparatively large, and there is ample room for overlapping of the rods and for the hooks or fishtails, so that most of the experts in ferro-concrete consider it quite unnecessary to use bars with mechanical bond. In ship construction, as has been previously stated, scantlings are reduced to a minimum, and the bars being very much closer together real difficulty is experienced in finding room for overlaps of the length required if ordinary round rods are used, and also for hooks, especially in longitudinal members. The problem is serious, and experiments carried out in France last year upon a river barge of 400 tons deadweight, which was purposely tested until rupture under load in the dry proved the ultimate failure to be due to the slipping of the longitudinal rods consequent upon the insufficiency of overlapping. It must be added that the overlaps were in fact considerably shorter than sound design would have required. But the indication given must not be neglected. It therefore becomes useful for ferro-concrete ship construction to adopt bars which present a greater adhesive power than ordinary round bars. Tests have proved that certain bars are obtainable which have a grip 60 per cent greater than that of ordinary rounds; their use will obviously reduce the amount of overlapping otherwise required. But such greater adhesion should not be obtained by the addition of sharp projections or ribs on the bars which might have a tendency to be the starting point of minute cracks in the concrete, and which, in addition, are useless from the point of view of the main stresses. In other words, the bond should be continuous, and should not entail an additional weight of steel. To sum up the question of the steel, the author has found the nearest approach to what he considers the ideal steel reinforcement for shipbuilding work in bars manufactured from mild steel in accordance with British Standard Specification for structural steel, but which, owing to their special shape and the physical treatment they receive after rolling, acquire an elastic limit of over 50,000 lbs. per square inch, present a satisfactory and continuous bond without sharp indentations or projections, and remain capable of cold bending round a bar of 1½ times their diameter without injury. experience gained from the behavior of the numerous ferro-concrete works in which it was used since 1915 will be of great help in that direction.

II.—Systems of Construction.

Having examined the constituting materials, one may now attempt to reply to the query: "What are the various systems of construction"? They seem to fall under two headings—Plastered ships; moulded ships.

(a) Plastered Ships.—The first cost of a mould in which to cast a ferro-concrete ship, in a similar way as is generally done for ordinary ferro-concrete work, is high, and it was natural that one should attempt to avoid using one. Many of the numerous river barges and pontoons built in Italy since 1902 consisted mostly of a steel mesh work set to shape and plastered on both sides with cement mortar, very much as a ceiling of a room is plastered on a metallic lathing. Italians are very clever cement plasterers, and the method proved successful for small craft which are never strained heavily. Small motor boats or canoes have been built similarly in various countries, including, of course, the small pioneer rowing boat built in France in 1849 by Lamjot, and which has now become historical. When one comes, however, to heavier craft, and particularly seagoing craft, mesh work is found to be not practical for the arrangement of the main steel reinforcement; the number of skilled plasterers able to do justice to such difficult work is very small at present; and what is more important, plaster work of that kind does not give a concrete sufficiently strong to meet the stresses imposed upon it. The claims of the "cement gun" in that respect do not appear as yet to be justified. The author is convinced that for all vessels of large size the plastering method has to give way to the method of moulding and casting, and he is under the impression that it will not be sanctioned by at least one of the Registry Societies, in view of experience lately acquired in that direction.

(b) Moulded Ships.—(1) In the first place, there should be a warning against the practice recommended by one or two American contractors of building a sort of rigid metallic work—lattice girders forming the skeleton of all the frames, and also the skeleton of the sides, and encasing this metallic framework in concrete. The advantages claimed are sim- analogous practice prevailed among a few designers in the analagous practice prevailed among a few designers in the early days of reinforced concrete construction, but it was gradually discarded in favor of the more scientific and efficient designs which have been in universal use for the last twenty years, the principle of which is that the reinforcement is not a rigid frame by itself. The author considers that there would be no appreciable saving in time, and there are very serious defects inherent to the system. All ferro-concrete experts agree that the ideal design in ferro-concrete is that in which the reinforcing rods are individually as small as possible and as numerous as is practicable, so that the stresses be distributed to the extreme possible limit throughout the mass of ferro-concrete. The result is best attained by the use of small rods and links. It has been very properly stated by the most eminent authorities on ferro-concrete that it is a new material and not a mere juxtaposition of concrete and steel: it has, in fact, qualities and idiosyncracies of its own quite distinct from those of its constituent elements. If, however, the steel is concentrated in parts of the mass instead of being distributed throughout, the work thus obtained loses those peculiarities just referred to; the concrete will not lend its properties to the steel and borrow some from the latter in so complete a manner, and vice versa. In particular, the large cracks so characteristic of ordinary concrete work, and unknown in ferro-concrete, would tend to appear, and this would be a very serious defect in ships. The work would also lose the resilience and elasticity which is so striking a character of ferro-concrete. Another point is that a rigid framework of that kind, instead of being made of round bars, would require flat bars and small angles; in fact, structural steelwork of the very kind that is most in demand today. It would also require the employment of steel workers of the very kind one wishes at the present time not to draw upon, seeing that all the steel work would have to be punched, bolted and riveted. Moreover, experience has shown that such a method of reinforcement is more wasteful in steel by 15 to 20 per cent. It has also been found in practice that in reinforced concrete work it is most advisable to avoid any sharp angles or corners in the steelwork, all such angles being potential starting points of cracks; and that concrete adheres less easily to comparatively large and flat surfaces such as presented by angle bars than to ordinary round bars. It may also be added that if, in order to avoid riveting, an attempt is made to use bolts, as the bolt holes will be greater diameter than the holes (so as to facilitate fitting up) there will remain throughout the framework an immense number of small recesses to which concrete will not have access; the steelwork will therefore not receive in those points the protection against corrosion which the concrete should afford it, and such points will be potential starting points of corrosion. For all those reasons, tempting as the idea may be at first to those not thoroughly accustomed to reinforced concrete work, rigid framing has to give way to the usual non-rigid round bar skeleton reinforcement.

(2) The Norwegian method of casting the boats upside down, launching them in that position, and letting the hull right itself in the water, has been profusely described and illustrated in the daily papers and magazines. The reason for that unusual procedure is stated to be a desire to avoid the use of double shuttering. But, as far as the deck and bottom are concerned, there is no more need for a double shuttering in the usual method than in the upside down one, and as regards the sides there is as much need for it in one as in the other. It seems that the upside down method has been used for very small vessels, 200 tons deadweight, but it is doubtful whether it is workable in the case of bigger craft, say, 1,000-ton or 2,000-ton boats, and the author is at a loss to see any advantages in it.

(3) In the construction of river barges in France, the desire to reduce the cost of shuttering has led to certain constructors experimenting with pre-cast wall plates of the required dimensions to fill the rectangular spaces between frames and stringers. The frames and stringers are cast in situ, and the wall plates set in position between them so as to be incorporated into the structure during their concreting, the bond being given by the ends of the reinforcing bars of the plates, which

protrude all round. Although the results were said to be satisfactory (at first, in any case) it is interesting to note that when the same contractors built larger river craft (600 and 1,000 tons deadweight) they abandoned the slab principle and reverted to casting in situ. For seagoing craft, which are submitted to hogging and sagging stresses, the author feels that the slabs would work loose, and further, the steel used in their construction, and which is in short lengths, would not be utilized for meeting the general stresses in such an efficient manner as it can be when the plates are monolithic with the frames and stringers. This mode of construction is therefore to be deprecated.

(4) Another "system" is that in which timber moulds are dispensed with for the walls by using two sheets of metal lathing between which the concrete is poured. Some of it works through the mesh and forms knobs upon the two outer surfaces, which knobs in turn form anchorage for plastering coats added later on. The objection against the use of plastering coats required to finish the surface has been stated before. Another drawback of this method is that concrete poured between two resilient sheets of meshing cannot be rammed or punned properly, and in consequence it is impossible to obtain a good, strong and impervious concrete. The advocates of this method, in fact, are said to recommend the addition of a waterproof coating, which the author has no doubt would indeed prove very necessary with such a method.

(5) Reverting now to the normal and usual method of construction, it can hardly be divided into systems. A few patents have been taken in the matter, but they mostly bear on questions of detail; the general principles underlying all the designs are the same, and it is merely the experience and skill of designers which may differentiate the various types adopted. In that respect the author is fully in accord with the remarks made by Mr. A. T. Wall in the Engineering Supplement of the Times regarding the absolute necessity for close co-operation in the design of ships between naval architects and ferro-concrete experts. The latter, or at any rate the broad-minded ones among them, fully recognize that the science of naval architecture and the practical experience which is necessary when applying its principles, require years to be acquired; and in the same way the extremely complex problems of ferro-concrete design as applied to naval architecture can only be solved by the application of years of experience. Excellent results will be the fruit of close co-operation, and the attempt to work independently of each other has already resulted in a number of failures, and will continue to do so.

Having thus reviewed the material and the method of construction of ferro-concrete ships, it is now necessary to inquire into the claims put forward by the advocates of such ships, and see whether they can be substantiated.

TABLE I ONE DECK SINGLE SCREW CARGO STEAMERS.

DEADWEIGHT ALL TOLD IN TONS.	1000		2000		4000		6000	
	STEEL	FERRO-CONCRETE	STEEL	FERRO-CONCRETE	STEEL	FERRO-CONCRETE	STEEL	FERRO-CONCRETE
LENGTH BETWEEN PERPS.	180'-0"	210'-0"	220'-0"	245'-0"	285'-0"	305'-0"	340'-0"	365'-0"
BREADTH MOULDED.	29'-0"	33'-6"	35'-0"	38'-9"	41'-6"	44'-3"	45'-9"	48'-0"
DEPTH MOULDED TO UPPER DECK.	15'-6"	16'-9"	20'-0"	20'-3"	25'-0"	25'-3"	28'-3"	28'-6"
MEAN DRAFT	14'-9"	14'-9"	17'-9"	17'-9"	21'-3"	21'-3"	23'-3"	23'-3"
DISPLACEMENT IN TONS	1600	2225	2910	3660	5580	6465	8240	9210

TABLE II FACTORS FOR CONVERSION OF DEADWEIGHT CARRYING CAPACITY INTO TOTAL DISPLACEMENT.

DEADWEIGHT ALL TOLD IN TONS.	1000	2000	4000	6000
STEEL VESSELS	1·600	1·455	1·397	1·373
FERRO-CONCRETE VESSELS.	2·225	1·830	1·616	1·535

TABLE III EXCESS DISPLACEMENT OF FERRO-CONCRETE VESSELS OVER STEEL VESSELS OF SAME DEADWEIGHT CARRYING CAPACITY.

DEADWEIGHT ALL TOLD IN TONS	1000	2000	4000	6000
EXCESS %	39%	25·8%	16·8%	11·8%

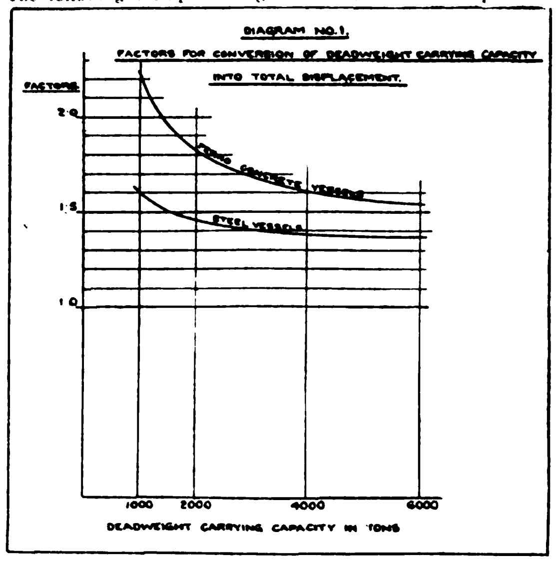
III.—Speed of Construction.

One of these claims is a great speed of construction. It must be borne in mind that up to the time of writing the biggest units launched are barges of 1,000 tons deadweight. For bigger tonnage no actual facts can be mentioned, but by inference experts may gauge pretty accurately the time required.

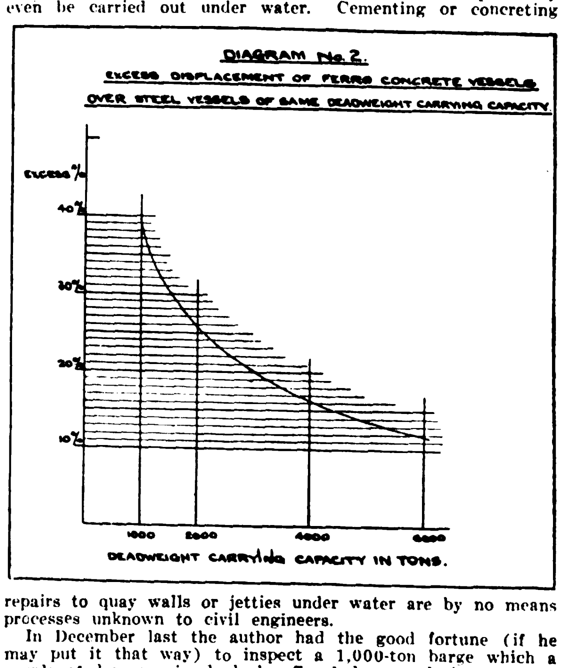
In the construction of a large number of 250 horsepower tugs now being built in France, the author was able to satisfy himself that two weeks were sufficient to erect the moulds (for repeat tugs; the erection of the first mould took somewhat longer) and place the steel in position. The process of concreting was occasionally carried out in 48 hours. All told, it is safe to say that in normal working the yard referred to completes a hull in three weeks. The tugs take water broadside on, and an average of three weeks is allowed for maturing. With the restricted amount of labor at present available, the said yard can turn out one of these tugs every week, but from explanations given to the author by the yard's manager it is certain that two tugs could be completed every week in normal times. In another place the author has seen in what was four months before a bare field, two 1,000-ton deadweight barges ready for launching, and several others following closely. Barges of that kind, or again, the hulls of small cargo steamers of 1,000 tons deadweight, may easily be turned out and launched at the rate of one every ten weeks from each slip in a well organized yard. For obvious reasons it is impossible at the present time to give precise figures as to the actual speed of construction of bigger ferro-concrete craft. However, having discussed the programs of construction both with British and with French contractors, the author considers that in regular working order the completion of the hull of 1,000 tons deadweight cargoes would take about 1½ months from start to finish. That of 2,000 tons 2 months. A 3,000 tons cargo would require 2¾ months, and a 5,000 tons about 4½ months. The time required for the fitting of machinery, etc, would be practically identical for such ships and for steel ships, so that from the above figures the total time required to complete the ship may be deduced. It will be understood that from 3 to 5 weeks has to be added to allow for the maturing of the concrete. In ordinary land work one considers generally that a test load may be imposed upon a new floor 5 or 6 weeks after its completion. But the concrete used in that case is not so rich in cement as for ships, and the richer the concrete the quicker the required strength is attained. It might be possible to utilize that period for partly fitting up the ship instead of waiting until she is afloat, so that the maturing period would not be lost altogether.

IV.—Ease and Speed of Repairs.

This question of speed in construction leads us to another important consideration, viz., the ease and speed with which ferro-concrete ships may be repaired. Ferro-concrete has been proved to withstand damage to a remarkable extent. One need only refer briefly to its excellent behavior during the earthquakes, during subsidence of foundations, etc. This is due to the monolithic character of the work and its great cohesion. The following example will give a clear idea of the possibilities of ferro-concrete in that respect. In 1909 a monolithic building was erected from Messrs. Mouchel & Partners' designs at Northwich, a district famous for appalling subsidences due to the extraction of brine from the lower strata. The building, boxlike fashion, rested on 20 foundation piers, but without connection with them, and it was arranged that the piers should be kept under observation, so that if any showed signs of subsidence packing should be inserted and the building jacked up. In December, 1915, signs of subsidence were detected, and a joint inspection was made by the Surveyor of the Northwich Salt Compensation Board and the author, when the almost incredible fact was revealed that out of the 20 piers 12 had subsided and parted with the superstructure, the latter remaining supported on 8 piers only. Enormous strains must have developed in the portions of the building thus transformed into big cantilevers, but the report stated that "thorough inspection of the whole building, with special attention to main beams, secondary beams and ceilings failed to reveal any trace of weakness or strain." Such is the resiliency, the power of accommodation to new circumstances, of ferro-concrete. Again, in 1907 an 8,000-ton steamer crashed into a ferro-concrete jetty in the river Thames. The engineer, Mr. C. S. Meik, M. Inst. C. E., stated at the time that if the jetty had been a timber one, the steamer must have gone right through it. As it was, the only damage was the destruction of a few piles and about 20 square feet of decking. It must be understood that damage to ferro-concrete work is always of a most localized nature. At the time of the great explosion at Silvertown in January, 1917, a steel girder weighing nearly one ton was blown up and fell headlong upon a ferro-concrete wharf some 50 yards away. It went through a panel of the decking, but the hole made was hardly more than 1 foot by 2 feet, the adjoining beams not suffering in the slightest; the damage was therefore insignificant and most easily repaired. This localization of damage, which is extremely important in ship construction, is borne out by observation of the effects of shell fire on ferro-concrete. On the western front a ferro-concrete water tower 52 feet high formed for a long time a convenient observation post for the Germans and a prominent target for our guns. When in March, 1917, the Germans proceeded with their so-called "victorious retirement," they took good care to bring down the tower by dynamiting its legs, the tank proper falling from its full height to the ground. But according to written statements, the shells which had struck the tank merely made circular holes through the sides and bottom, and the fall to the ground caused only local cracks. After small repairs, the tank could be used either on the ground or jacked up gradually to its original position.



Such local damage as may occur in ferro-concrete ships will be most easily repaired, the hole being blocked up by providing a small timber shuttering and filling the hole with new concrete, after having added, if need be, a few strengthening bars. By using a very rich mixture of concrete, the patch will be able to stand the water pressure in a couple of days or even less, and if need be, one may not remove the shuttering before putting to sea again, for further safety. Such a repair may even be carried out under water. Cementing or concreting repairs to quay walls or jetties under water are by no means processes unknown to civil engineers.



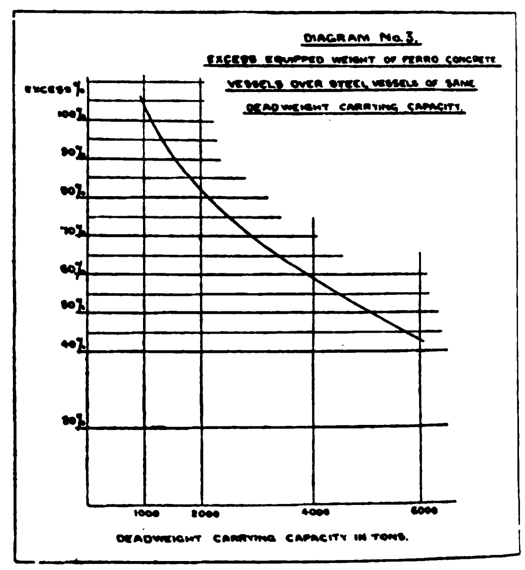
In December last the author had the good fortune (if he may put it that way) to inspect a 1,000-ton barge which a couple of days previously had suffered damage during a faulty launching; it had been repaired as explained above, and was then afloat and in excellent condition. Several instances of damage to river or canal barges in use abroad have been recorded, pointing all to the same conclusion, and all investigators seem agreed that repairs to ferro-concrete ships will be quicker and much cheaper than to steel vessels. Alterations to the design in course of erection, or while the ship is in service, are quite easy. The author has witnessed in France a fairly sweeping alteration in the position and arrangement of hatchways and companions in a vessel nearing completion, which confirms this statement.

V.—Lasting Qualities of Ferro-Concrete Vessels.

Views on that aspect of the question are difficult to express, for the reason that experience has not yet been obtained regarding their behavior at sea over long periods. Most probably steel shipbuilders found themselves in the same predicament when steel was first put forward as a substitute for timber. Let us also proceed by inference. We know that ferro-concrete on land is a most permanent material, requiring no upkeep, no painting, and increasing in strength with age. We know that the same applies to ferro-concrete sea work or tidal work, jetties, quays, etc., when properly designed and carried out. There may have been a few cases (very few indeed in proportion to the number of successful works) in which defects developed. But in those cases the defect can always be traced to causes which do not affect the principle of ferro-concrete, and could have been avoided by taking due care. The author has read practically every attack made upon ferro-concrete and its lasting properties, but up to the present he has not seen one that was vital. Local examples being always of special interest, one may properly refer here to a ferro-concrete jetty built in 1901 at the C. W. S. works, Dunston-on-Tyne, with a rise and fall of tide of 15 feet, and which is in absolutely perfect condition, although it is now submitted to much greater shocks than was anticipated owing to the increased tonnage of vessels accommodated.

We know, further, that ferro-concrete vessels for river or canal or harbor work have stood the test of time very well indeed; comprehensive lists of such vessels have been printed so often lately that it is unnecessary to repeat them.

On the other hand, we know that seacraft are submitted to much more severe strains, and this is where doubt may arise. To overcome the difficulties which confront ferro-concrete seacraft, one must first of all realize them fully, and recognize the inherent drawbacks of the material. It is then comparatively easy to devise means for removing the disabilities. That there will be failures cannot be doubted. Most of them will arise from imperfect understanding of the effect of combined stresses. But the experience already at our disposal is sufficient to show that some of the difficulties encountered can be overcome by more careful designing, and there are good grounds for assuming that the ferro-concrete vessels which it is now proposed to build up to a certain size will have the necessary lasting qualities. The question now arises as to what is the limiting size of ferro-concrete ships, but before trying to give a tentative reply to the query it is necessary to face one of the great defects of ferro-concrete vessels, viz., their weight.



VI.—Weight of Ferro-Concrete Vessels.

It is so obvious that ferro-concrete vessels are heavier than steel ones that there is no need to explain why. The important point is to make a comparison between vessels of the two classes and of same deadweight carrying capacity. The designs of vessels upwards of 1,000 tons deadweight prepared by the author's firm comprise one deck single-screw cargo vessels of 1,000, 2,000, 4,000 and 6,000 tons deadweight, and the comparison will be limited to those. It must be stated that the full detailed working plans for the larger units are not quite completed as yet, so that slight alterations in the figures here below given are possible.

In the following tables the figures referring to the steel vessels have been kindly prepared by Mr. R. Cole and Mr. H. Burgess, of Messrs. Sir W. G. Armstrong, Whitworth & Co., Limited, the design of the ferro-concrete vessels has been prepared in collaboration with Mr. T. G. Owens Thurston, of Messrs. Vickers, Limited, and to them the author wishes to tender here his best thanks.

The above Table I. allows one to compare at a glance the main characteristics of the vessels.

From the figures in that table another Table II. has been prepared, which gives the factor for converting deadweight carrying capacity into total displacement, both for the steel and the ferro-concrete vessels figuring in Table I.

Diagram I. gives a graphic representation which enables one to see that the disadvantages attaching to ferro-concrete vessels in the matter of weight are greater in the case of small tonnage; although ferro-concrete vessels cannot hope to become as light as steel vessels even for big tonnage, the disadvantage becomes less and less marked when the size grows. This is due to the fact that the minimum thickness of concrete which is necessary for practical reasons, even for small units, need not be increased at the same rate when tonnage grows bigger. Where 3 inches are necessary for a 1,000 tons cargo, a 2,000 tons requires hardly 4 inches.

Diagram II. and Table III. show the variation of the extra displacement of ferro-concrete vessels, whereas for a 1,000-ton deadweight steamer the total displacement of the ferro-concrete vessel exceeds that of the steel vessel by as much as 39 per cent; for 2,000 tons deadweight the excess is only 30 per cent; for 4,000 tons deadweight, 18 per cent, and for 6,000 tons deadweight under 15 per cent. It seems probable that for vessels over 6,000 tons the excess may be lowered further still, very slightly, say to 14 or 13 per cent, but that would seem to be the limit, at any rate, until new developments take place in ferro-concrete naval architecture. But even as

(Continued on page 24.)

Operation of the Motorship "Hamlet"

Ten Thousand Ton Diesel-Driven Merchant Vessel Runs for Seven Months in American Coastwise Service Without a Single Half Hour's Delay From Engine Trouble

By B. HALD, First Assistant Engineer M. S. "Hamlet"

BEING a reader of the motor-engineering magazine "Motorship," and having up till now therein noticed very little about the Norwegian M. S. "Hamlet," I volunteer herewith some information concerning this vessel, hoping it may interest your readers.

The "Hamlet," which was built at "Goetawerken" in Gothenburg, Sweden, August, 1916, is a twin-screw oil-tanker of 10,060 tons displacement. Her engines are of the Diesel-motor type, built at "Diesels Motorers" works in Stockholm. The motors are of the "Polar" two-cycle type; number of cylinders is six to each engine; cyl. diam. 24", length of stroke 36".

The cylinders are close-ended and on the cover is mounted solely one valve—the fuel valve. The starting air, which is inlet underneath the pistons in the bottom of the cylinders, is distributed through cylindrical slide-valves; each starting valve serves two cylinders. Consequently there are only three starting-valves on each engine. The scavenging air is supplied from six double-acting pumps, three to each engine; they discharge the scavenging air into longitudinal cast-iron receivers wherefrom the air through slide-valves is distributed to all the working-cylinders. Six three-step compressors—three to each motor—supplies fuel ignition and starting air. The reversing gear is Hesselman's patent, and the pistons are water-cooled.

THE MOTORSHIP "HAMLET"

Two Diesel-motor-driven air compressors excepted, there is practically no auxiliary machinery, the main engines doing all the various auxiliary functions required. The steering-gear is worked by compressed air. Compressors, scavenging pumps, circulating, bilge and piston cooling pumps, fuel and lubricating-oil pumps are all balance-driven by the main engines. Speaking about auxiliary machinery, there are three dynamos all told; they work the electric light plant and radio-telegraph. One is belt-driven by the main engines, one Diesel-motor-driven and one is steam-driven.

Two boilers supply steam-winches and pumps when the ship is in port. The pump room is mid-ships; two centrifugal pumps driven by turbines of de Lavals type and one Worthington donkey-pump discharges the cargo of 6,500 tons comfortably in 30 hours.

Each of the main engines has 2,200 i. h. p. capacity: the effective h. p. is 1,650. On a consumption of 9 tons crude-oil in 24 hours and 100-102 revolutions a minute she runs easily 11 knots an hour loaded ship. As far as I know her engines were the most powerful two-cycle marine-motors in the world before the American naval tanker "Maumee" was launched.

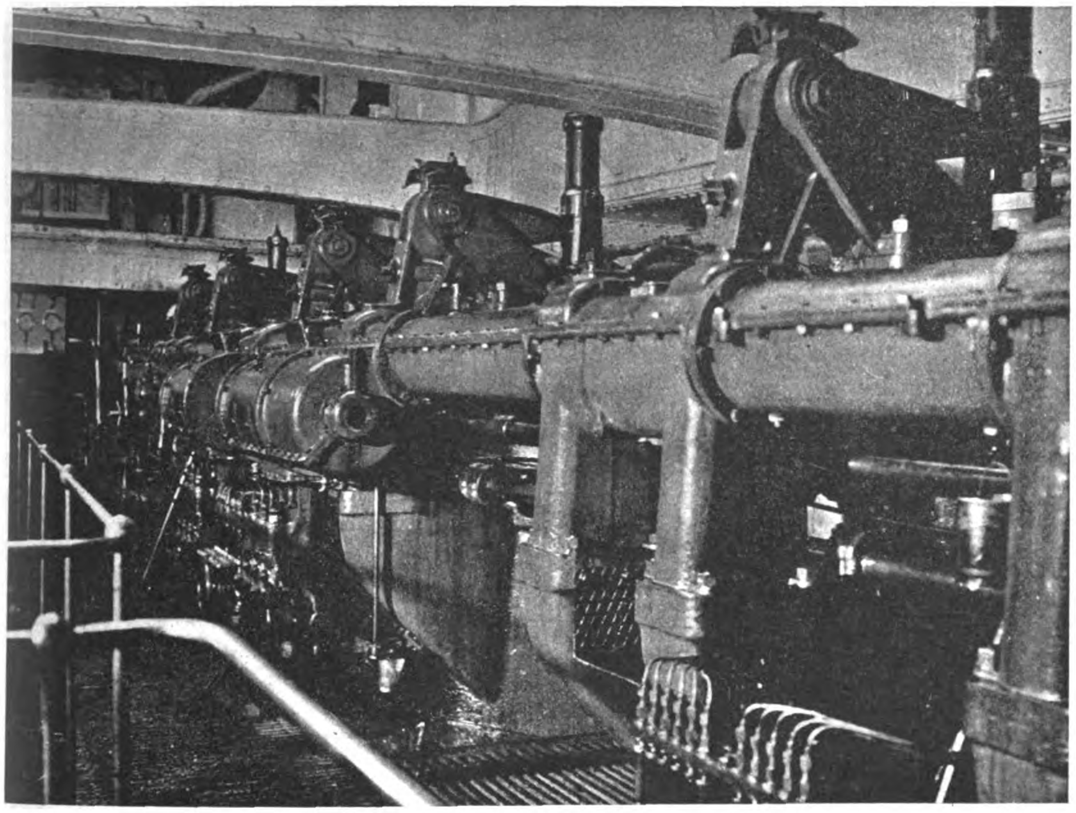
After six months running the cylinders and cylinder-covers were opened out and everything proved to be in first-class condition; not one of the piston-rings had fastened and no cracks or pittings could be detected in any of the pistons.

The "Hamlet" has been engaged in coast-wise trade in this country for the last seven months. During that period there hasn't been required any assistance from machine-shops and no extra hands needed, all necessary work being executed solely by the engine-room staff. The ship hasn't been delayed one single half-hour on account of engine trouble, and there has been no break-down or serious trouble of any kind ever since the ship was launched. She is in every regard a success and a great credit to the firms that built and equipped her.

According to Mr. R. M. Campbell, the British representative of the builders of the Diesel engines of the motorship "Hamlet," she has been in regular service since Sept. 3, 1916, and that up to March last year, her engines had run 3,400 hours in actual sea-service. During that time no trouble from bearings, hot or otherwise, had been met. The bearings were taken down on that date and all were found to be in excellent condition, with nice smooth working surfaces.

At the same time, the shafts were examined and carefully measured, when the wear in the bearings was found to be 0.18 mm., or 0.0072 of an inch, which we consider very satisfactory for the first half-year's running.

The bottom ends have also run splendidly, and were found to be in the very best possible condition. The top-ends have also run well, as only on three occasions has a slight heating in one of these bearings been reported in the engineer's log, since the vessel was delivered in September, 1916. This heat was due to dirt or stoppage in the oil supply and was easily brought down again to normal without any stoppage, the bearings being in very good condition.



VIEW OF THE PORT ENGINE OF THE MOTORSHIP "HAMLET"

FISH-OIL AS FUEL FOR SMALL MOTORCRAFT

Experiments made in Denmark with motors for fishing boats to determine the practicability of using fish oils for operating them appear to have been so successful, according to Commercial Attache I. W. Thompson, that it may be possible for fishermen who now have boats equipped with kerosene motors to make some slight changes and use this kind of fuel. It is even proposed, he says, that fishermen may make their own cod-liver oil while at sea for use in their motors.

When the experiments were called to the attention of the manager of a Copenhagen firm, which makes Diesel engines, for the purpose of getting his opinion regarding them, he replied to Mr. Thompson: "I take pleasure in confirming that the fish-oil for Diesel motors will be excellent for use as a moving power. Further I beg to say that, no doubt, the said oil will also be practicable for smaller fishing boats where the motors do not work according to the principle of Diesel motors, but the principle of explosive motors."

GERMAN POWER SCHOONERS REFITTED.

The two power schooners "Neptune" and "Atlas," formerly belonging to German owners and seized in San Francisco harbor at the opening of the war, have been towed over to the yards of the Barnes & Tibbet shipbuilding plant where they are now undergoing a complete overhauling and being refitted for service under the American flag. They have already been stripped and are being recaulked. New copper sheathing will be put on the vessels and they will be put in first-class condition for use.

A CORRECTION.

In our February and March issue we referred to several large Werkspoor-Diesel engined ships being built to the order of Mr. Fred Olsen of Christiania. It should have been Mr. Otto Thorensen of Christiania, who will own the Werkspoor ships, and Mr. Fred Olsen, who will own Burmeister and Wain engined vessels. Mr. Fred Olsen is one of our subscribers.

MOTORSHIP

A journal devoted exclusively to Commercial and Naval Motor Vessels and their operation. Issued on the 25th of each month.

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ELECTRIC-DRIVE FOR MOTORSHIPS.

Many arguments of a controversial nature are outlined in an interesting article that appears elsewhere in this issue entitled, "Electrical Drive for Diesel Motorship Propulsion," which we have published without necessarily agreeing with all or any of the opinions expressed. Space has been given to it just as we gladly would find space for sensible documents advocating electrical transmission, because both sides of every technical question always should be given, and the various "fors and againsts" thoroughly debated, such correspondence then becoming a valuable and permanent record of the experiences and beliefs of those who are vitally concerned.

To the article in question we particularly draw the attention of electrical-engineers in the hope that they will not let the arguments therein raised against electrical-drive remain unchallenged. The author of the article certainly does not hesitate to demonstrate in a clear and concise manner both theoretical and practical reasons for his views, and backs them with concrete instances where experiments have been made with large ships. Hence, if there are any flaws in his claims it is to the interest of electrical-engineers to reveal them in a vigorous manner, and our columns are open for the purpose. If "Engineer's" arguments are left unchallenged they are sure to leave a deep impression with shipowners.

THE SUBMARINE ACTIVITY.

Sixty-five Allied Commercial Craft Attacked During Week Ending March 23rd.

IN the January issue of this year of "Motorship" we pointed out that—"We must not regard the submarine as no longer being a serious matter for this country and our allies to tackle and that probably over a year from last March (1917) will be needed for Germany to get all her large U-boats re-built and to complete new boats of a better design, and that it most likely will be April or May of 1918 before Germany can get an efficient fleet of large U-boats operating in mid-Atlantic where they will be much harder to locate and destroy.

Let us note if what we anticipated has proved to be reasonably correct. Week ending March 23rd:

Great Britain.	
Steam ships over 1,600 tons gross sunk	16
Steam ships under 1,600 tons gross sunk	12
Fishing vessels sunk	1
Ships unsuccessfully attacked	19
France.	
Steam ships over 1,600 tons gross sunk	1
Steam ships under 1,600 tons gross sunk	5
Steam ships unsuccessfully attacked	2
Italy.	
Steam ships over 1,500 tons sunk	3
Sailing ships over 100 tons sunk	2
Sailing ships under 100 tons sunk	3
Steam ships unsuccessfully attacked	1
Total	65

This means that the submarines were very active, as 65 allied commercial craft were attacked during that one week, of which 43 were sunk. No announcement was made regarding American and neutral vessels. When the great land drive started it was expected that Germany would make special endeavors at sea, but without submarines she could not have done much, whereas she gave indications of having, together with Austria, a good-size fleet on the ocean, so may have brought out all available reserves.

The previous week 17 British merchantmen were lost, and for several weeks preceding that the weekly loss was 18 vessels. This would indicate the urgent need for ships, especially of a funnelless, mastless, and smokeless type that will evade the submarines.

Despite the increased activity of submarines the effective measures now being taken by the allied navies should keep them in check, and eventually defeat them to an extent where shipbuilding will be more rapid than the sinkings.

The Following Was Published in the "New York American" and Associated Papers on March 6th

SOMEWHERE-IN-AMERICA, March 5.

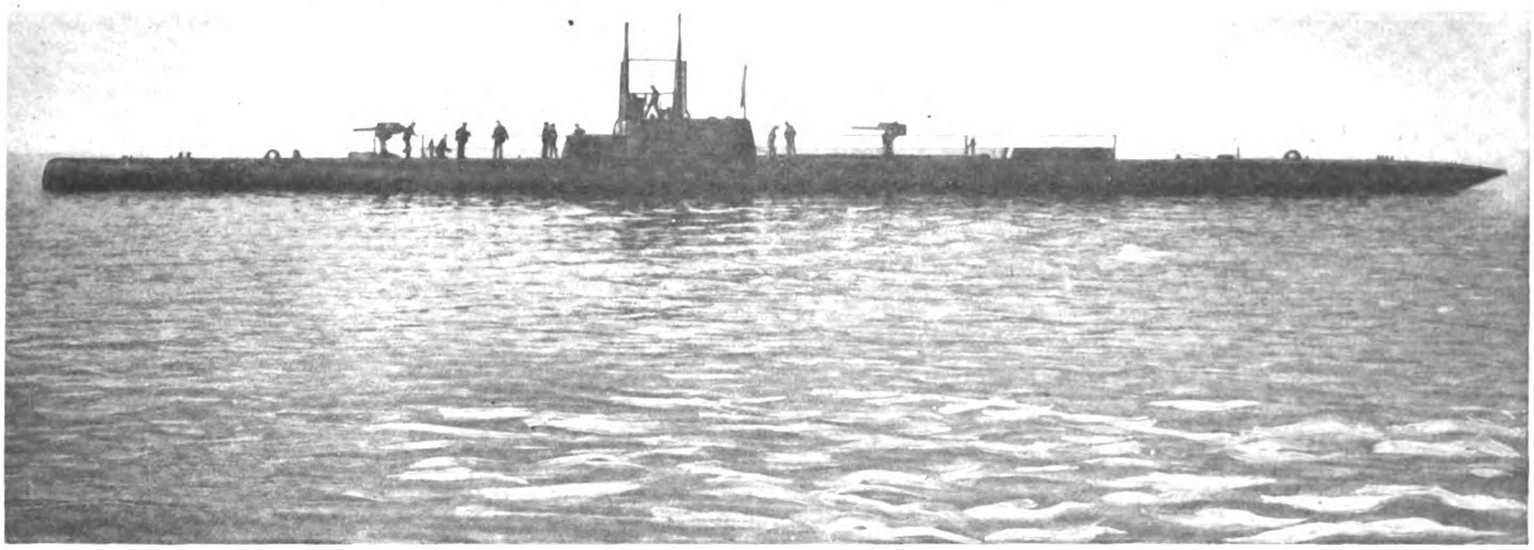
A FEW years ago.
* * *
THERE WAS a boy.
* * *
NAMED MILLER Freeman.
* * *
AND HE was the editor.
* * *
OF A monthly paper.
* * *
AND HE had a launch.
* * *
AND EVERY little while.
* * *
WE'D GO on a cruise.
* * *
AND MILLER.
* * *
WOULD BE the captain.
* * *
AND WHATEVER he said
* * *
WE HAD to do.
* * *
WE'D DO.
* * *
AND ONE day.
* * *
HE MADE up his mind.
* * *
HE'D HAVE a little navy.
* * *
OF HIS own.
* * *
AND HE went to Washington.
* * *
AND CAME back home.
* * *
AND BEGAN to organize.
* * *
THE NAVAL Militia.
* * *
OF THE State of Washington.
* * *
AND THERE was an old monitor.
* * *
THE GOVERNMENT owned.
* * *
AND HE asked for that.
* * *
AND HE got it.
* * *
AND HE was the captain.
* * *
AND HAD a lot of gold.
* * *
ON HIS shoulders.
* * *
AND AROUND his sleeves.
* * *
AND I used to kid him.
* * *
AND HE'D just laugh.
* * *
AND GO out to his ship.
* * *
WITH HIS naval militia.
* * *
AND GIVE them orders.
* * *
AND WALK around.
* * *
LIKE AN admiral.
* * *
AND THE war came.
* * *
AND MILLER Freeman.
* * *
WIRED TO Washington.
* * *
THAT THE Naval Militia.
* * *
OF THE State of Washington.
* * *
WAS READY for service.
* * *
AND IT was.
* * *
AND THE orders came.
* * *
AND IT went away.
* * *
AND MILLER came back.
* * *
AND THIS morning.
* * *
HE SENT me a message.
* * *
AND I went out.
* * *
TO AN old golf course.
* * *
WHERE I used to play.
* * *
BESIDE A lake.
* * *
AND THERE were tents.
* * *
AND NEW frame buildings.
* * *
AND A parade ground.
* * *
AND DOWN on the lake.
* * *
WAS MILLER'S ship.
* * *
AND ABOVE them all.
* * *
ON A great tall staff.
* * *
WAS THE Stars and Stripes.
* * *
AND HUNDREDS of boys.
* * *
WERE THERE on parade.
* * *
AND A band was playing.
* * *
AND CAPTAIN Miller Freeman.
* * *
WITH THE rank of commander.
* * *
IN THE United States Navy.
* * *
SHOOK HANDS with me.
* * *
AND HE was the boss.
* * *
AND WHAT I saw.
* * *
WAS HIS dream come true.

I THANK you.

Italy's Emergency Merchant Fleet

Over Fifty Large Diesel-Driven Motorships and Tankers Now on Order in Various Italian Shipyards—Important Navel-Diesel Developments Made During the War

FOR many years Italy's merchant fleet, like that of the United States has been semi-decadent, and the war has brought home the realization that any country who hopes to become or remain a great nation must have a large cargo-carrying merchant fleet, and that swift mammoth passenger liners are of secondary importance to slower and lumbering freighters or tankers. But, ranking above all, the immediate and urgent necessity is ships, ships—and ships, and that the type of merchant vessel which best lends itself to the most rapid standardized construction, and which can carry the greatest amount of cargo for the amount of labor, materials, and time spent in its construction is the proper ship to build at this vitally urgent moment.



THE SUBMARINE "FIAT-SAN GIORGIO"

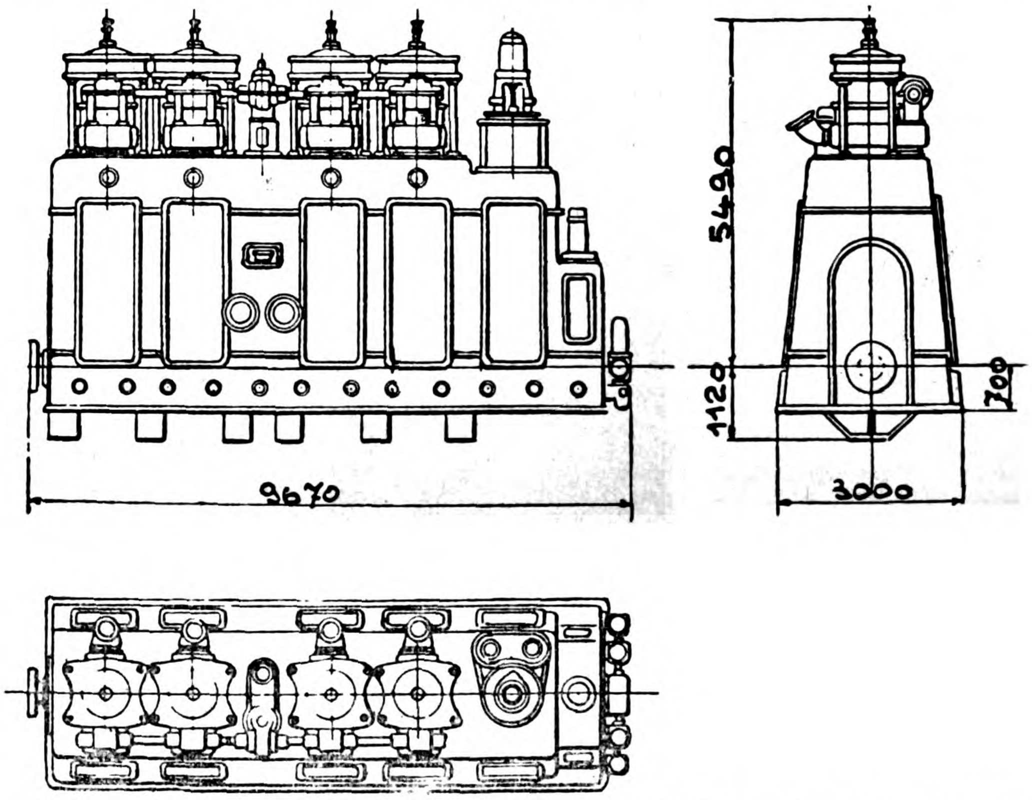
Having decided that the Diesel-driven motorship ideally met this requirement, Italian shipbuilders and owners decided to proceed with all possible dispatch with their construction, and not build steamers exclusively because by so doing the first few vessels might be launched a little sooner or because of the initial delay that their may be in completing the first motorships. They were encouraged in their decision and actions by the knowledge that the possession of motorships would leave them after the war with the most modern type of ocean cargo-carriers, which will be able to favorably compete against the oil and coal fired steamers of any other country in the great peace-war of trade that ultimately must come. Also that this type of ship is much more likely to be remaining in their hands after the war and not on the bottom of the sea, sunk in one of Austria or Germany's ruthless submarine attacks, because of the absence of coal-smoke enabling them to better evade the U-boats.

Consequently there are on order in five different Italian yards today over fifty Diesel-engined motorships of between 2.000 and 10,000 tons that are due to be completed before the end of 1919. Of these vessels 18 of 8.100 and 10.000 tons d. w. c. are to be completed in 1918 and 18 next year at the yard of the Fiat-San Giorgio, Ltd., Mugiano.

We asked an official of the company to the United States of this shipbuilding company why they were building this class of vessel, and why they went to the great expense of developing the crude-oil internal-combustion-engine when they easily could have continued the construction of steam-driven ships for which they already had facilities. We sought this information because we realize that from a business point of view it may not be to the advantage of builders to go to all the time and trouble and expense of the necessary changes in their works, and to pay the cost of the experimenting and development, it being the shipowner that receives the advantage. His reply was that they were building motorships because they are far superior to steamships and meet much better the present urgent needs of their country and at the same time leaves Italy well prepared for the future. And that they have sacrificed money and labor in order to secure for the new era of ship propulsion the motors they needed.

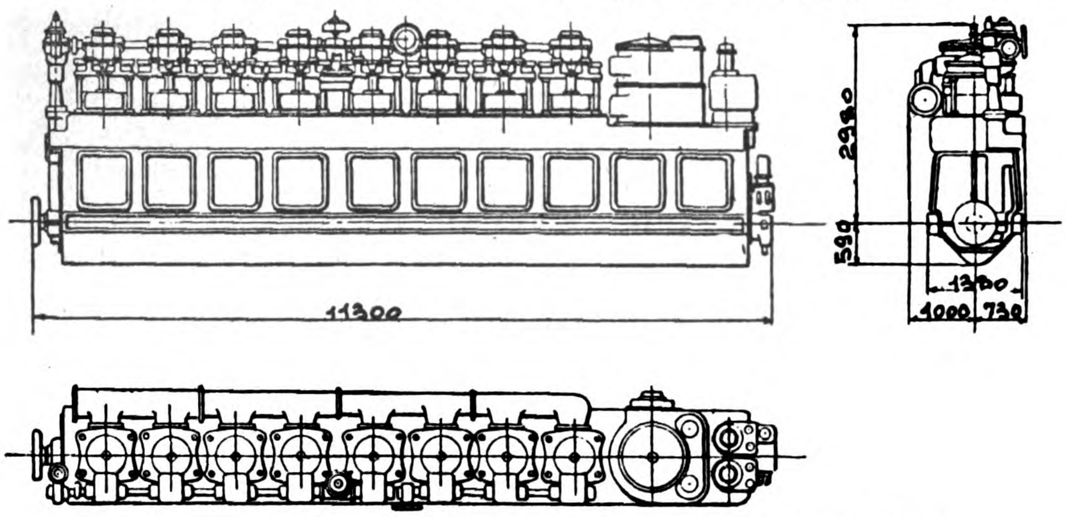
While no one in America must do anything that will delay the present shipbuilding program, it does seem a pity that our own shipowners and our Government could not have seen earlier what the Italians saw. Because, the war will not last forever and the people of the United States do not desire to be left with great fleets of merchant-craft that only can be run at a financial loss in over-sea competition with the economical motor vessels of foreigners. Let us speed-up the construction of every ship now under construction; but let every additional craft hereafter laid down be propelled by economical and efficient internal-combustion-engines. Then if the war is over two or three years from now, our merchant motorship fleet will just be commencing to be placed in service. It is better late than never—provided it is not too late! Possibly also it may not be too late to change the machinery of such ships already ordered, but on which work has not actually been started or the materials made, in which case the change should cause no delay.

Before proceeding further with the merchant ships it may not be out of place to hint at the im-



THE FOUR-CYLINDER MERCANTILE-TYPE FIAT-SAN GIORGIO TWO-CYCLE DIESEL ENGINE AS INSTALLED IN THE STANDARDIZED 8100 TON CARGO SHIPS. EACH ENGINE DEVELOPS 1000 B. H. P. AT 110 R. P. M.

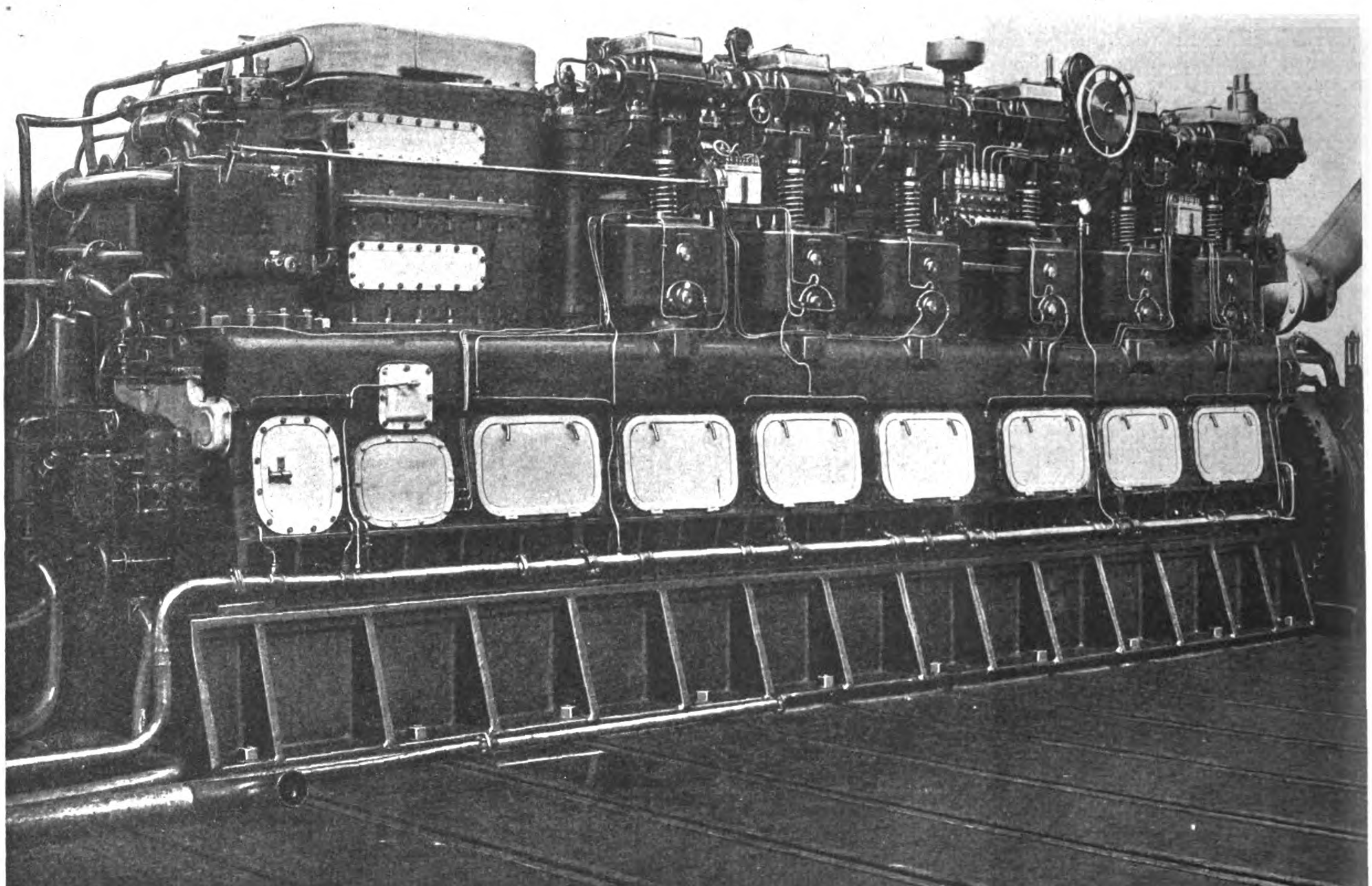
portant developments that have taken place in Italy with the naval-type of marine Diesel engine, but, of course, we are unable to give anything like the information we should wish to do, and so



THE FIAT-SAN GIORGIO HIGH-SPEED NAVAL REVERSIBLE MARINE DIESEL ENGINE

records of some great marine engineering progress must be left until peace has been declared.

We are enabled to give outline drawings of a high-powered, high-speed, Fiat-San Giorgio direct-reversible Diesel engine which has been designed



FIAT-SAN GIORGIO HIGH-SPEED MOTOR, 1300 B. H. P.

to meet special requirements, and a study of them indicates to us, that, while the engine is of the crosshead type, it is low enough to be placed under an armoured deck and narrow enough for three to be placed abreast, even if the ship be fine-lined and very narrow.

What these engines are for we have not been permitted to know; but, to any naval expert a total of 6,000 shaft h. p. on a weight of 216 tons should be sufficient to give a "Scout" a speed of 25 to 26 knots.

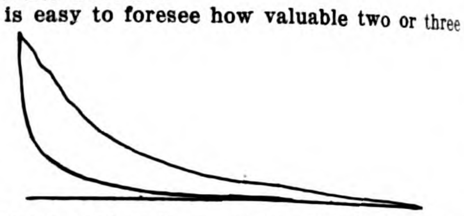
This Diesel engine has eight working-cylinders, with compressors and scavenging-pumps arranged at the forward end and driven directly off the crankshaft, and develops 2,000 brake-horse-power at 320 revs., per minute; 1,750 b. h. p. at 280 r. p. m.; or 1,600 b. h. p. at 250 r. p. m. on the two-cycle principle with a weight of but 72 tons, including coolers, filters, air-injection bottles, and the usual fittings on the engine. The flywheel, starting-air bottles, propeller shaft, and engine-room equipment and pipings, are not included in this weight; but in our estimation a set of these engines together with all engine-room equipment and auxiliaries, propellers, and shafting, should not weigh more than 325 tons at the maximum, which is very excellent for 6,000 shaft h. p. (equivalent to about 7,200 steam indicated h. p.). This gives a weight of 121 lbs. per b. h. p., or equivalent for propelling purposes to steam machinery having a weight of 101 lbs. per indicated h. p. The engines without auxiliaries have a weight of 80½ lbs. per b. h. p., or equivalent to steam engines, boilers and water, weighing about 67 lbs. per i. h. p.

Each of these Diesel engines is 37′ 0″ long overall, by 9′ 6″ high from crank-shaft center to top of valve rockers; and 5′ 8″ maximum width including exhaust-pipe. The width over engine bearers is 4′ 6″.

It may be thought that such an engine is for a large submarine, but, submarine engines as a rule are not direct-reversible, do not require starting-air bottles, and often have no flywheel, also the Fiat-San Giorgio submarine engine of the same power and speed has six cylinders and a weight of but 70 tons. Therefore, cannot we surmise with reasonable assurance that it has been developed for an Italian "hush-ship" class.

Part of the importance of such a vessel is that at full-speed she will require not over 1¼ tons of navy fuel-oil per hour, so that if called upon to do such a thing she could run for 200 hours at 25 knots (or 5,000 sea-miles), at least so far as fuel capacity is concerned, if she carried 200 tons of oil in her bunkers.

It is easy to foresee how valuable two or three



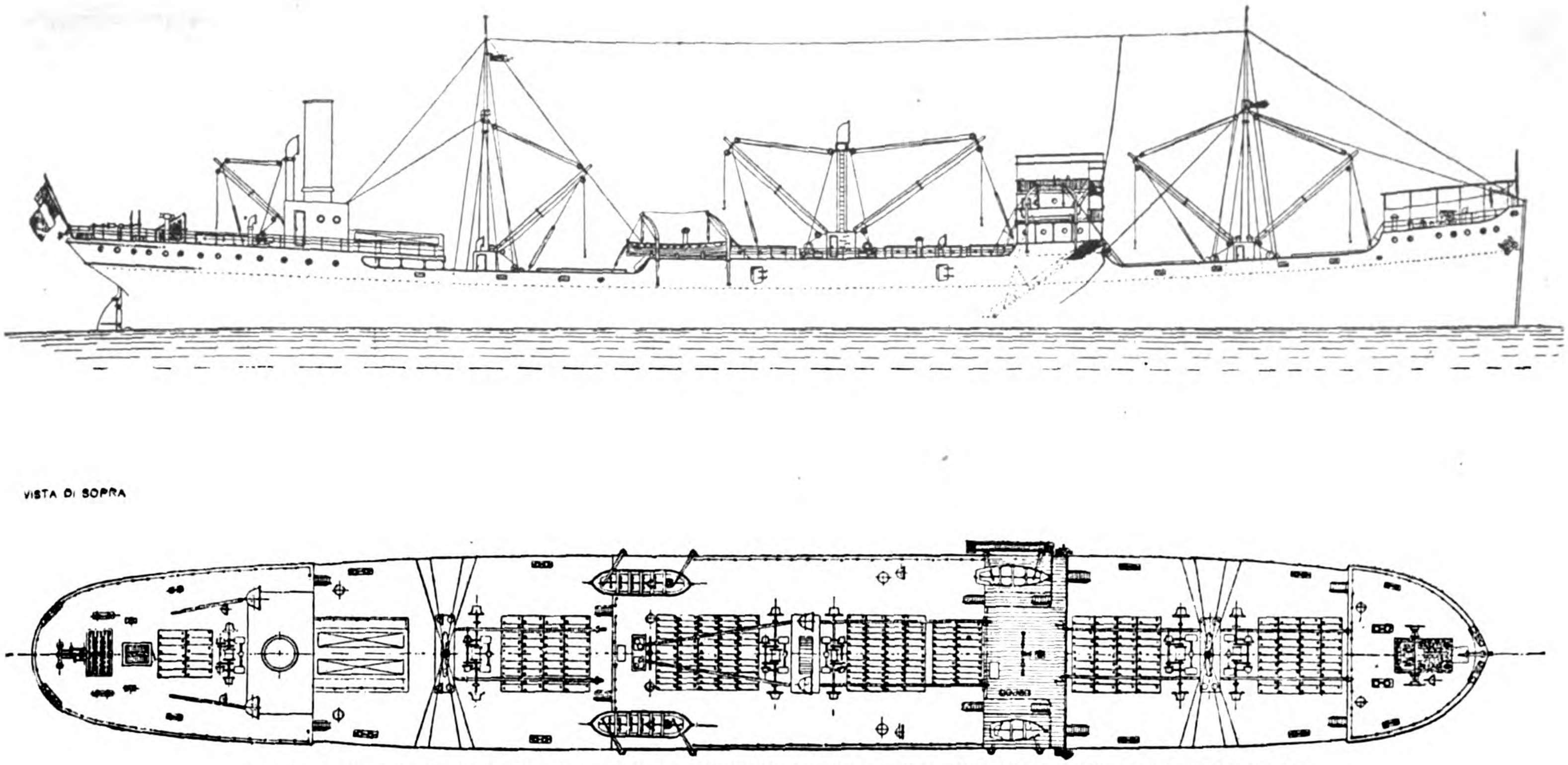
INDICATOR CARD FROM A FIAT-SAN GIORGIO HIGH-SPEED NAVAL DIESEL ENGINE OF 1300 B. H. P. AT 360 R. P. M.

of these Diesel engines would make the 200 ft. destroyers of the so-named "Eagle" class now being fabricated by Henry Ford, and what a great relief it would mean to the naval tankship supply service, thus leaving a certain number of tankers free for other important service.

Whilst we are unable to give a photograph of one of these 2000 b. h. p. Diesel engines we are able to give pictures of a submarine of about 1,000 tons together with an illustration of one of her twin six-cylinder two-cycle type 1300 b. h. p. Fiat-San Giorgio motors, and the latter is of interest as it is of higher rated power than any high speed naval Diesel engine yet completed in the U. S. A. The submarine is between 190′ and 200′ long and is equipped with two guns.

Before us as we write is a chart of a test of a naval engine of the same size and speed, which was one of a number supplied by these Italian builders to an allied admiralty during the middle of 1917. That the chart is accurate we can assure our readers as it was signed by the naval officials of the Admiralty concerned.

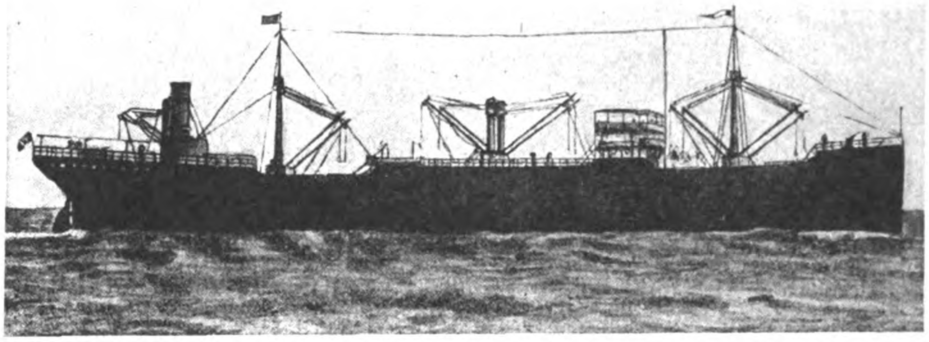
A study of the chart shows that a maximum power of 1372.6 b. h. p. was developed at 386 revs. per minute, and that 1340 b. h. p. or over, was maintained for the greater part of the trials, the average speed being a little over 375 r. p. m. The fuel-consumption averaged 239.9 grammes per



PROFILE AND DECK PLAN OF THE FIAT-SAN GIORGIO STANDARDIZED 8100 TON DIESEL-DRIVEN MOTORSHIP

brake-horse-power per hour, and the lubricating oil averaged 14.2 grammes per brake-horse-power; both of which may be considered very excellent for a two-cycle engine. Furthermore, the trial shows that the engine was capable of maintaining over its rated power. At 312 r. p. m. the engine developed almost 1,000 b. h. p. (998 on a consumption of 234.9 grammes per b. h. p. hour, and 837 b. h. p. at 290 r. p. m. on a consumption of 221.3 grammes per b. h. p. hour. Consumption has since been bettered.

To revert to the Italian emergency merchant motorship fleet, we propose in this article to deal only with those building by the Fiat-San Giorgio, as this fleet is the most important of them all, the total tonnage due to be launched this year at their Muggiano yard being about 130,000 tons deadweight-capacity, and a similar amount each succeeding year, with a probable extension later on. At present only vessels of 8,100 tons will be built, because of the importance of rapid construction, and so sixteen vessels of standardized size will afford as rapid construction as the largest of the new American steamship yards, especially as it doubtless will be possible for the Italians to construct their machinery at a higher rate of speed, this being facilitated by reason of it meaning 128 cylinders, 128 pistons, and 32 crankshafts, etc., all of the same size.



SHOWING HOW THE STANDARDIZED 8100 TON DIESEL MOTORSHIPS BUILDING BY THE FIAT-SAN GIORGIO WILL LOOK AFTER COMPLETION

In the building of these vessels standardization arrangements have been thoroughly carried out, and so the output of submarines and destroyers will remain undiminished.

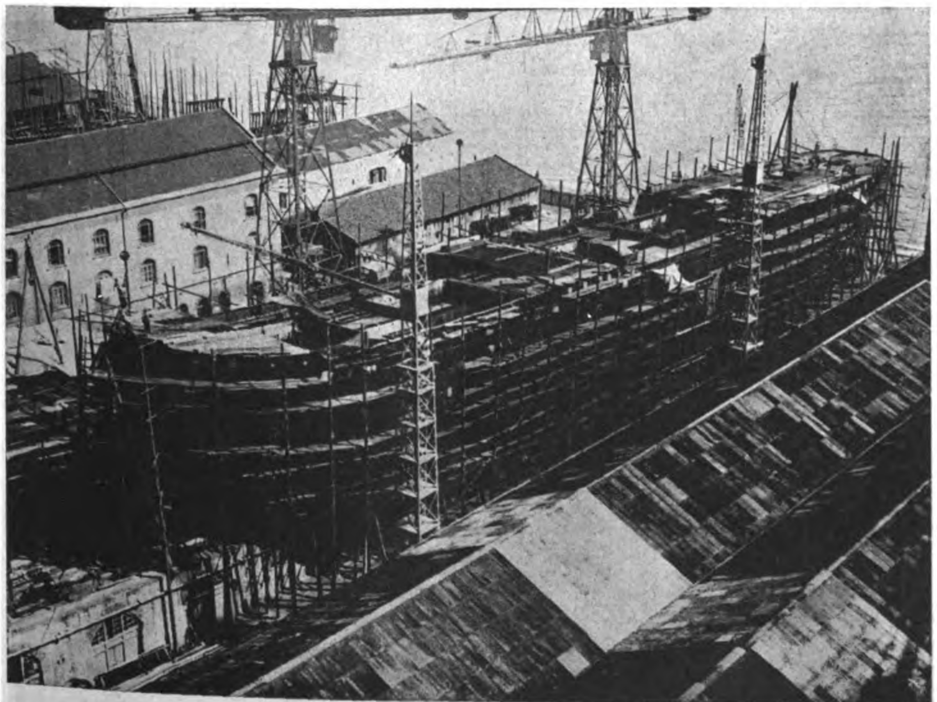
The following are the dimensions of the standardized motorships now being built:

Length o. a., 390 ft.
Length b. p., 378 ft.
Breadth (extreme), 50 ft. 9 in.
Breadth (moulded), 50 ft. 8 in.
Depth (moulded), 30 ft. 3 in.
Draft (loaded), 24 ft. 6 in.
Deadweight, 8,100 tons.
Gross tonnage, 5,580 tons.
Fuel in double bottoms, 900 cubic meters.
Speed (trial trip), 11 knots.
Service speed, 10½ knots.
Normal power, 2,400 shaft h. p.
Equivalent steam power, 2,900 indicated h. p. (about).
Number of engines, 2 four-cylinder motors.
Type of machinery, two-cycle Reversible Diesel.
Make of engine, Fiat-San Giorgio, Turin.
Builder and designer of hull, Fiat-San Giorgio, Spezia.
Fuel-consumption at 11 knots, 10½ tons (73 barrels) per 24-hour day.
Fuel consumption per effective h. p., 0.45 lbs. per hour.
Fuel guaranteed, any high density oil containing up to 20% pitchy and tarry matter.
Lubricating oil consumption, 0.017 lbs. per h. p. hour.

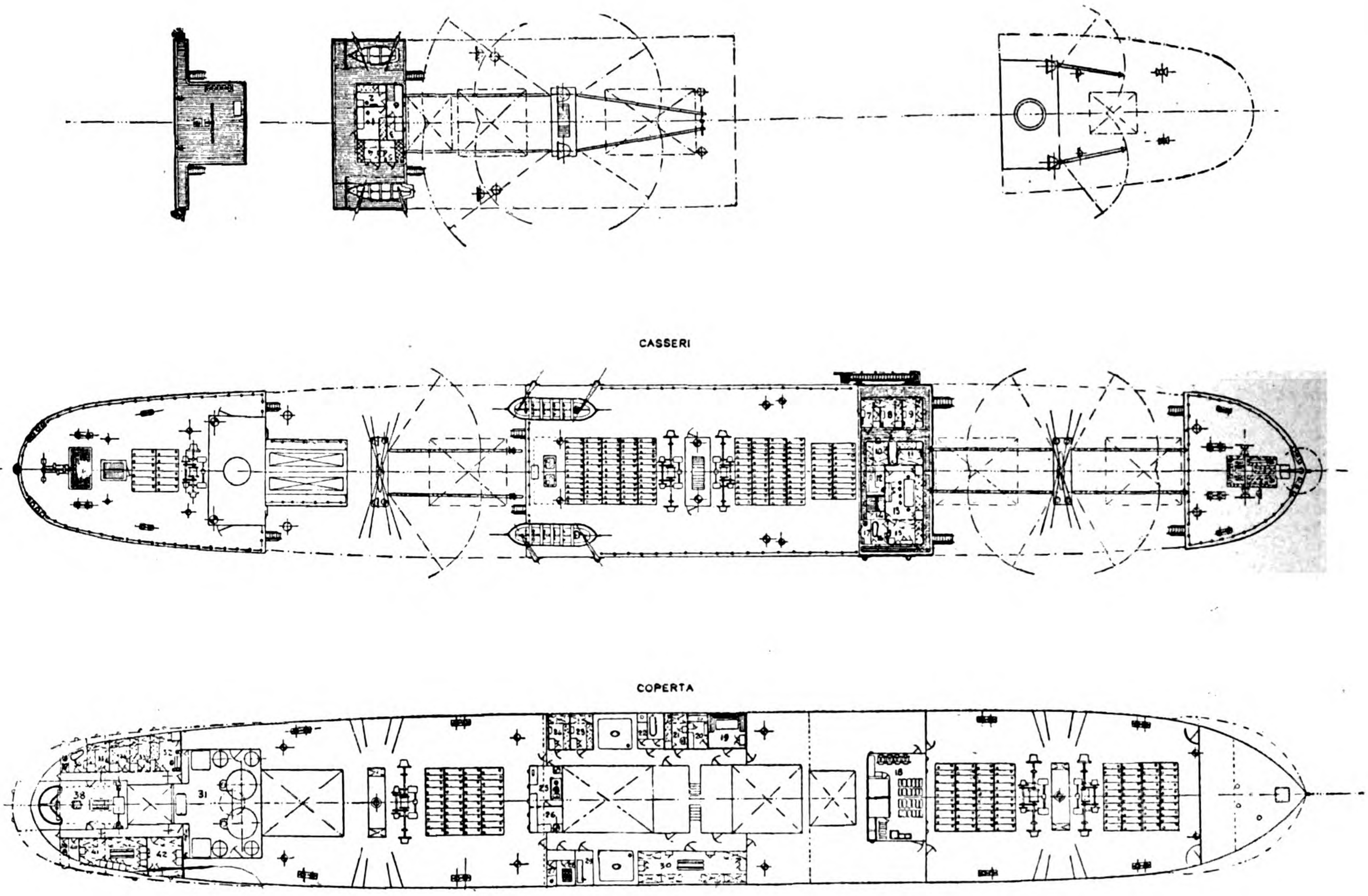
These ships will be of the single-deck type with special framing for allowing cargo holds free from pillars and stanchions. The poop bridge and forecastle will be 2.286 meters high. In addition to the fuel in the double-bottoms, special tanks will be constructed alongside the walls of the hull in the engine room. These service tanks will contain sufficient fuel for 10 to 12 hours running and are situated at such a height so as to allow easy flowing of the fuel-oil from them to the pumps on the engine.

For the purpose of operating the auxiliaries there are two donkey-boilers arranged in a steel housing on deck over the base of the stack, which also is utilized for carrying away exhaust-gases from the main engines.

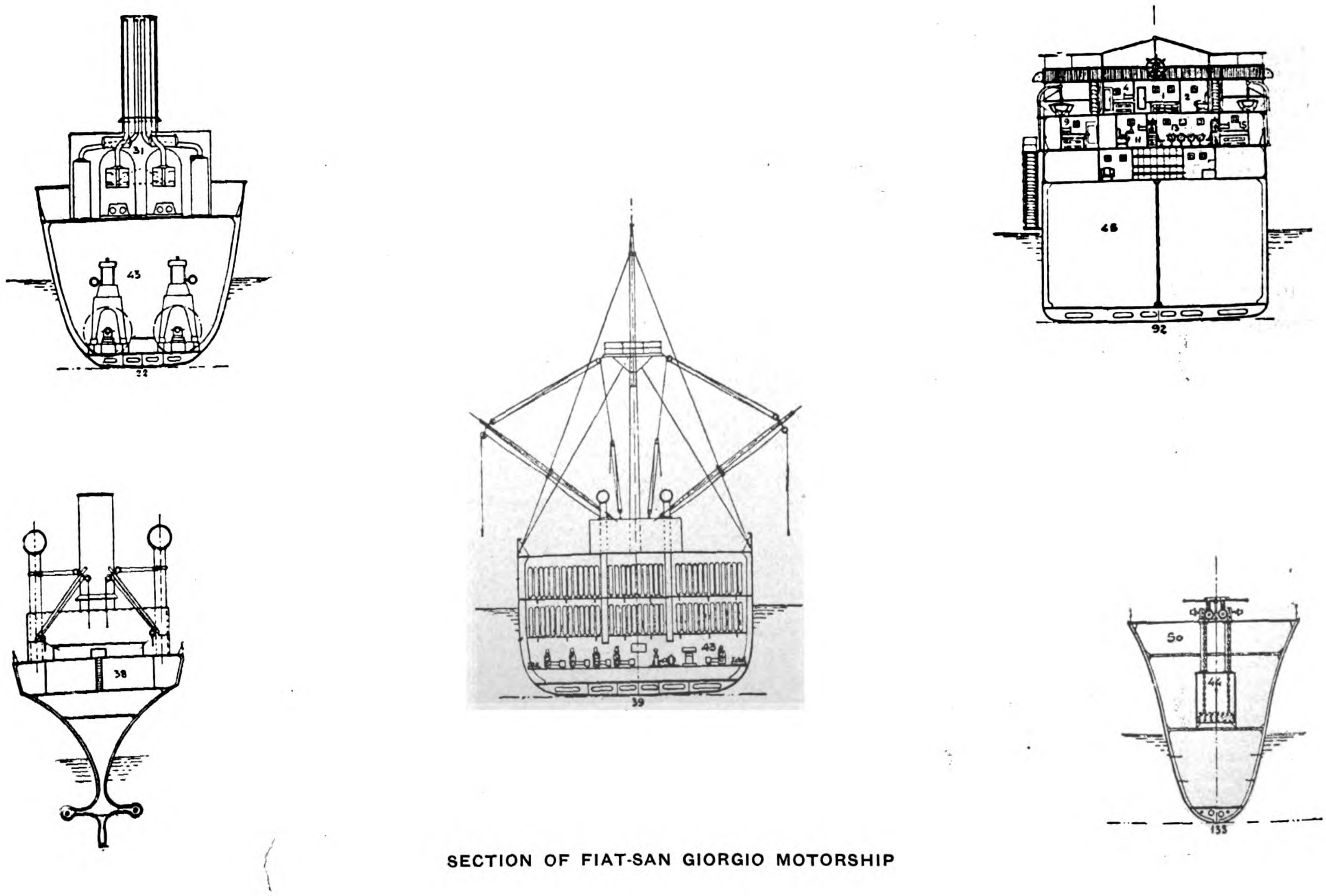
The Diesel engines installed—two per ship—



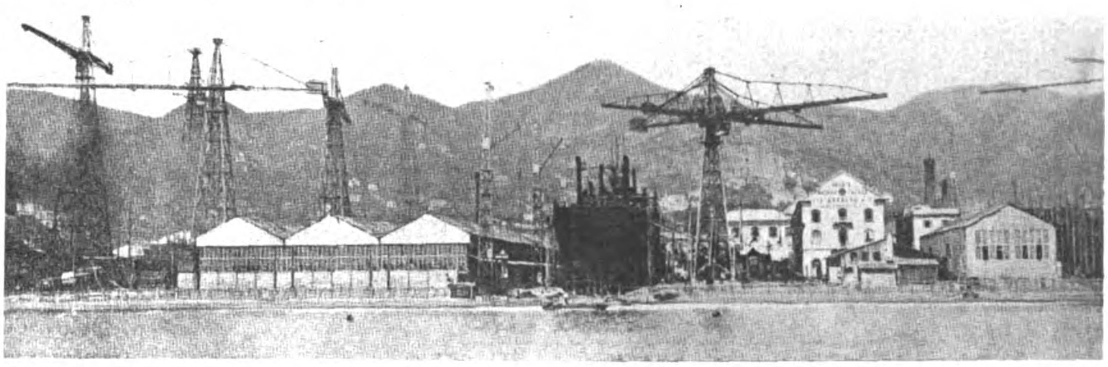
A STANDARDIZED 8100 TONS D. W. C. DIESEL-DRIVEN TYPE OF SHIP BUILDING AT THE ANSALDO SHIPYARD, SESTRI PONENTE



ACCOMMODATION AND DECK ARRANGEMENTS OF FIAT-SAN GIORGIO MOTORSHIP



SECTION OF FIAT-SAN GIORGIO MOTORSHIP



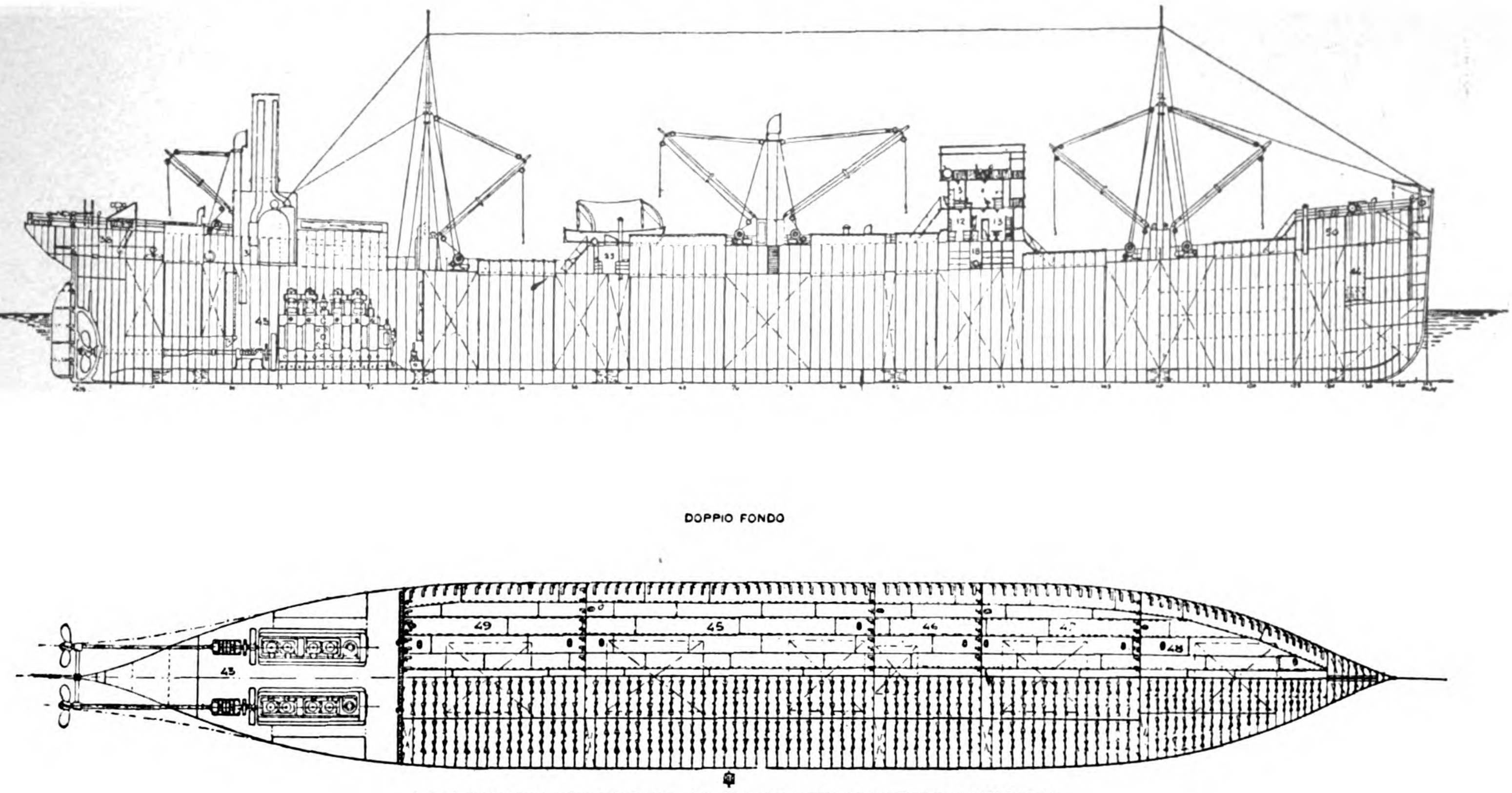
PART OF ANSALDO'S STANDARDIZED DIESEL MOTORSHIPBUILDING YARD AT SESTRI PONENTE

are of the direct-reversible crosshead type, with four cylinders each working on the two-cyc'e, single-acting principle, and have a bore and stroke ratio of 1.43. Each has an output of 1200 b. h. p. (1650 Diesel indicated h. p.) at 110 revs. per minute, or equivalent to about 1450 steam i. h. p. But, the engine is so designed that it can be run continuously to give 1350 b. h. p. at 125 r. p. m., or 1100 b. h. p. at 100 r. p. m. without changing the efficiency of the motor.

When developing 1200 shaft h. p. from each engine continuously, the daily (24-hour fuel consumption will be 10½ tons (73 barrels), not including the donkey-boiler. A steeamship of equivalent power, namely 2,900 i. h. p., will burn at least 31 tons (217 barre's) per diem if oil-fired, or 37½ tons if coal-fired, and would carry about 600 to 700 tons less cargo per transatlantic voyage than these motorships.

The mean-indicated-pressure of the engine at normal load is 7.4 kilos. per square centimeter, or 105.24 lbs. per square inch, while the mean-effective-pressure is 4.45 kilos. per square centimeter. The mechanical-efficiency is 75 per cent, which may be considered unusually excellent for a two-cycle type engine.

Motorships of somewhat similar standardized design and size as the ones just described offer so many marked advantages that we trust it will not be long before the U. S. Shipping Board Emergency Fleet Corporation places orders for a considerable number, and the best steps would be to lay down a spec'al yard and engine-shops where nothing else would be built, and where operaters could be trained while the machinery was being built. It stands to reason that the Fiat-San Giorgio would not lay themselves open to such a great risk in binding themselves to completing so many vessels, and absolutely passing over steam at such a critical time, unless they were absolutely confident of the success of the Diesel-driven merchant motorship. We of this country cannot any longer ignore, or be indifferent to, what Italy, Holland, Denmark, Norway, Sweden, Great Britain and Japan all are busily doing along these lines.



LONGITUDINAL SECTION OF AN ITALIAN STANDARDIZED MOTORSHIP

SKANDIA COMPANY MAKES IMPROVEMENTS.

The city of Oakland, Cal., has granted the petition of the Skandia-Pacific Engine Co., to allow it to close Peterson street in front of its present plant to allow the extensive improvements, which have been in contemplation for some time, to be made. The Skandia has just completed some buildings on the opposite side of the street and by this permission it will connect up these new buildings with the old plant and also put in new equipment that will, according to estimation, double the capacity of the plant.

NEW MOTORSHIP FOR A. P. A.

A new sea going launch is being built for the Alaska Packers Association at the yards of William Cryer & Son, of Oakland, Cal. The new vessel will be a duplicate of the "Grebe," belonging to the same company. She is 72 feet in length with a beam of 16 feet. Three cylinder 110 h. p. Standard Gas engines will furnish the power. She will be completed in time to take part in this season's catch and will be used especially in towing fishing barges from the fishing grounds to the company's packing houses. The "Osprey," built by the same people for this company was given her official trial in March and proved herself to be a great success. She is 75 feet in length and has a beam cf 20 feet. Two 85 h. p. Standard Gas engines furnish her power.

BRITISH OIL-ENGINE BUILDERS MAY AMALGAMATE.

There is, we understand, a likelihood of Vickers, Ltd., the British Westinghouse Co., and Wm. Beardmore & Co. amalgamating, and negotiations now are in progress with this end in view. All these concerns are builders of marine heavy o.l-engines.

THE 200-FT. EAGLE CLASS SUBMARINE-DESTROYERS.

According to reports the new "Eagle" class of submarine-destroyers, now being built by Henry Ford of Detroit, will be 200 ft. long, by 25½ ft. wide and will have a draught of 8 ft. As they will carry 5-in. guns, and will be equipped with detecting devices (l.stening to propeller sounds) and will be carrying depth bombs, they should be capable of searching for, and fighting, practically the largest German submarines. Already the "pattern" boat has been completed at the Detroit factory, and the new yard on the River Rouge soon will be completed.

370,000 TONS D. W. C. OF DIESEL MOTOR-SHIPS FOR ONE COMPANY.

The East As:atic Company advise us that they have in service 15 motorships of about 120,000 tons d. w. c. and have contracted for a further 250,000 tons d. w. c. of Diesel motorships up to 14,000 d. w. c., and are contemplating ordering further motorships.

FUEL-OIL IN ENGLAND.

Previously we have referred to the search being made for oil in England by the British Government. Private oil interests also will drill for oil, and Lord Cowdry (Mexican Eagle Oil) will spend $2,500,000.00 for that purpose. At present they are awaiting the arrival of drilling machinery from the U. S. A. If oil is found in England in any considerable quantity, it will become more important than ever for America to have economical Diesel-driven tankships for transatlantic service.

DIESEL-DRIVEN 700 B. H. P. FISH CARRIER.

Now completing in Scotland, at the yard of J. & G. Forbes, Sandhaven, is a twin-screw fish carrier for Newfoundland, which will have a speed of 13 knots. Her length is 160 ft., and two 350 b. h. p. two-cycle type Polar-Diesel engines are being installed.

NORWEGIAN SHIPPING.

The present capitalization of Norwegian shipowners is 1,000,000,000 Kroners (about $300,000,000) and represents a fleet of about 2,100,00 tons. Before the war their fleet of 2,550,000 tons only represented 240,000,000 Kroners capital.

Senate Committee on Commerce Investigates the Motorship

Testimony of Thos. Orchard Lisle Before the Investigating Committee

ON March 28, at the invitation of the Senate Committee on Commerce, Mr. Lisle appeared before that body and in a very complete manner backed up with data and facts regarding the use and development of the oil engine on the Continent and in the United States, delivered some very enlightening statements before that body. He showed what other nations are doing with the oil-engine, what expansions they are planning for the intense trade rivalry after the war, what other nations are doing with the oil motor during the war and urged that similar action be taken immediately by the United States not only as a war measure but also as a protection for American

ruly firemen worries; reduced engine-room staff, because stokers are dispensed with. The revolutions of the propeller are constant and are not dependent upon the moods or energies of the stokers. You probably know that with the steam-fired ship with the slacking of the firemen the steam pressure drops down and the speed of the boat drops. But it is a purely mechanical proposition with a motor ship and does not depend on any stokers.

Senator Nelson. State that again.

Mr. Lisle. With the motor ship the amount of fuel pumped to the engine and burned is a purely mechanical proposition, measured all the time with a pump which is regular. But on your steamship you have firemen stoking coal, unless it is an oil-fired ship, who sometimes work well and sometimes do not, and if they do not work well the steam pressure drops and the speed of the ship drops.

With motor ships the propellers rarely race in heavy weather because of the pressure in the cylinders. When the propeller comes out of the water the engines do not race because the

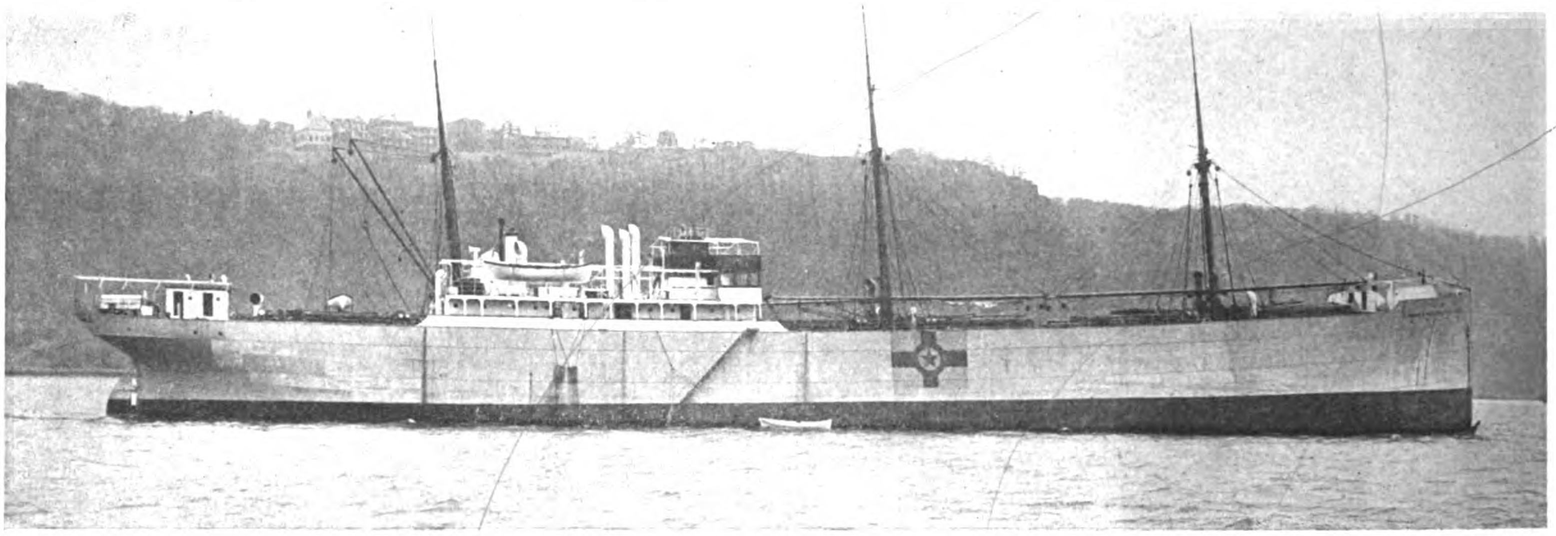
I received a letter last week from the secretary of Counsellor of State Anderson of Denmark, who is the head of the East Asiatic Co., and he says his company has entirely abandoned steamships in favor of Diesel motor ships, and that they have in service 15 motor ships aggregating 120,000 tons deadweight capacity, and that they have contracted with Burmeister & Wain for another 250,000 tons deadweight capacity of Diesel motor ships of up to 14,000 tons deadweight capacity each.

Senator Vardaman. Will you explain to me that Diesel ship? I was not listening to you very closely. What special advantages are there in the motor ship?

Mr. Lisle. The main thing is that it carries 10 to 12 per cent additional cargo more than a steamship can carry.

Senator Vardaman. Why is that?

Mr. Lisle. Because the consumption of oil fuel weight for weight is one-third of the amount a steamer requires, due to the greater thermal efficiency of the Diesel engine. You see, the Diesel engine has about 38 per cent thermal efficiency.



MOTORSHIP "KRONPRINZ GUSTAF ADOLF" —Photo Edwin Levick, N. Y.

Owned by the North Star Company. 9625 tons displacement. 6550 tons D. W. C., 3730 tons gross. Dength. 362 feet: 51 feet 3 inches beam. and 25 feet 6 inches moulded depth. riven by two Burmeister & Wain Diesel engines of 1000 I. H. P. each. Speed 10¾ knots.

post-war trade. We print Mr. Lisle's testimony verbatim:

Statement of Thos. Orchard Lisle.

The Chairman. State your name and place of residence and occupation.

Mr. Lisle. My name is Thomas Orchard Lisle, editor of Motorship, South Ferry Building, New York.

The Chairman. Motorship is a publication issued how often?

Mr. Lisle. It is issued monthly and has been published for two years. Do you wish a copy?

The Chairman. You might show the committee a copy.

(Mr. Lisle thereupon exhibited to the committee a copy of Motorship.)

The Chairman. Mr. Lisle, what has been your business heretofore?

Mr. Lisle. I have been seven years engaged as a practical engineer, and since then I have been engaged as a consulting engineer and technical journalist; about 15 years' experience along those lines altogether

The Chairman. Where have you lived during that time?

Mr. Lisle. Four years in the United States and the rest of the time in England.

The Chairman. Do you know about the development of the motorship?

Mr. Lisle. It is a thing I have watched right from the earliest days, from the very first vessel.

The Chairman. What do you desire to submit to the committee?

Mr. Lisle. What would you like to hear first, Senator, the advantages of motorships at the present time or what they are doing abroad?

The Chairman. Just make your statement in your own way. Perhaps the advantages might be given first, but in which ever order you desire.

Mr. Lisle. Perhaps I would just as well give the importance of it first.

The importance of motorships may be grasped from the following: Just before the war in Europe the American-Hawaiian Steamship Co. were considering converting their oil-fired steamers to Diesel motor power; but the demand for bottoms suddenly arose and time to lay up the ships could not be spared.

But had these ships been converted their fleet today would carry at least 20,000 tons additional cargo every voyage and the cost of operation would be considerably reduced.

Let it also be added that 500 Diesel ships of 6,000 loaded tons displacement each would every voyage to Europe carry at least 200,000 tons more cargo than would 500 steam-driven ships also of 6,000 tons loaded displacement, and would dispense with about 4,000 stokers, whose services possibly could be used for other war purposes, and ships would never be held in harbor waiting for bunker coal.

The following are the chief advantages of motor ships: About 10 to 12 per cent gain in cargo capacity; have about 40 per cent special emergency reserve power over normal when chased by submarines, with about 10 to 15 per cent reserve power compared with steam; but this reserve power can only be used for a few hours, otherwise damage to the engine results. There is no coal smoke to betray the presence of the motor ship to the enemy submarine. You know, submarines watch the sky line for the column of smoke going up, and then lie in wait, and if they find it is a destroyer they keep down below; if it is freighter and they have a chance to sink her they come up. There is a very large reduction of the fuel bill, although the ships cost more for the size of the ship. Absence of stand-by charges in the port; greatly increased cruising radius; less frequent bunkering; elimination of ungovernor cuts off the fuel instantly and stops them from racing.

There is better propulsive efficiency when the ship is in ballast. There is smaller wage and food bills. The ship is always ready for instant starting. You have not got to get steam up 12 hours ahead or anything like that. Very rapid maneuvering is possible, with full ahead to full astern in five seconds, with a 5,000-ton ship. The waste exhaust gases can be used for economically operating the auxiliaries; dispensation of steam piping on deck when electrical auxiliaries are used, and better all the year around propulsion efficiency.

There is another thing I would like to mention, and that is, every existing sailing ship now in the service should be fitted with auxiliary oil engines, so that their annual carrying capacity is at least doubled.

Senator Nelson. That is, sailing vessels?

Mr. Lisle. Yes; and then they no longer would be at the mercy of wind and tide.

Senator Nelson. You mean by that they should have Diesel engines?

Mr. Lisle. Or surface ignition oil engines.

I had a telegram from Mr. Hurley a few weeks ago, and he said the Shipping Board Emergency Fleet Corporation had that matter now under consideration.

And also no new sailing ships should be laid down without some arrangements for auxiliary power. All along the coast of Maine they are building quite a number of sailing ships which have no motors.

Another thing is, every ship, whether steam or motor, sailing to the war zone should have an emergency motor-driven electric lighting set on deck, which is independent of the main boilers, so that if the ship is torpedoed at night and the boilers put out of action, the crew have got electric lights to see in the launching of the boats. All these foreign battleships and some liners have such installations, including the White Star Line boats and the Holland-American Line passenger boats.

Senator Nelson. These motors are only used, my understanding is, on smaller ships, so far?

Mr. Lisle. That is a great mistake a lot of people have got into believing. I have here a few examples of some of the ships which have been built abroad; boats ranging up to 15,000 tons have been built [exhibiting photographs to the committee].

Senator Nelson. Do you have the same kind of turbines as you do for the others?

Mr. Lisle. No turbines are used. The Diesel engine is a power unit in itself. It requires no boilers.

Senator Nelson. No, but I mean, you have a propeller, do you not?

Mr. Lisle. Yes; the engine is direct-coupled to the propeller shaft.

Senator Nelson. I used the word "turbine," but I mean that you need a propeller for these ships as you do for the steam ships?

Mr. Lisle. Oh, yes. A Diesel engine resembles very much an ordinary reciprocating engine with double the number of cylinders.

Senator Vardaman. Does it run with gas?

Mr. Lisle. They use crude oil, practically the same as is used under oil-fired boilers. You can use heavier oils, but if you use very dirty oil it gives the engineers more trouble, and they will naturally say the engine will not use crude oil, as they want to use cleaner oil. If you use the dirty oil you ought to pay your engineers a little more for the extra work required in doing that, and since you have no stokers you can pay the engineers the extra money and then they take proper interest in their work.

I want to give a few details about what is going on abroad. Lloyd's Register shows nearly 500 Diesel vessels.

compared with about 20 per cent for a steam engine. That means to say, instead of carrying, we will say, 1,000 tons of coal in the bunkers of the big ship, you would only carry about 300 or 400 tons of oil-fuel, and you would use that extra space for cargo. Then, there are no boilers.

Senator Vardaman. How do you generate power from this oil?

Mr. Lisle. You would spray it into a cylinder containing highly compressed red-hot air, and it ignites that fuel, which burns and expands, and as it expands it forces down the piston and turns the crank shaft. You save the boiler space, or most of it, because the engine is a little longer, and then you save all the water in the boilers and the water you have to carry for the boilers.

Senator Vardaman. Do you not have to carry water when the Diesel engine is used?

Mr. Lisle. No; only drinking water for the crew.

Senator Vardaman. You do not have to use any water?

Mr. Lisle. Sea water is used for cooling, which is pumped in from the side of the ship, but a ship has to carry about 150 tons of fresh water purely for the boiler when steam engines are used, even though they have condensers on board.

Senator Vardaman. What is the difference in the cost between this machinery and the other?

Mr. Lisle. This machinery costs about 10 per cent extra, but the main thing is that you are able to carry more cargo on a motor ship. So when you consider the amount of cargo space saved and the cost per ton of cargo, the cost is a little less.

Senator Vardaman. Is that Diesel engine altogether as reliable as the ordinary steam engine?

Mr. Lisle. Quite as reliable today. Good engines are being worked in a way that steam has never done—that is, they are making 40 or 50 or 60 days nonstop runs, which is practically unknown with the steamship. There are, of course, a lot of people who have built the Diesel engine who have had no right to build that engine; who did not regard it seriously and went ahead and made a failure of it. Ships were put in service and gave bad results and created bad impressions upon people who saw them. But many firms abroad have developed these high-power engines and they have had very high service from them, and all those builders are ready to supply our shipbuilders with drawings.

The Chairman. Is not that the danger? You might order Diesel engines and they might turn out all right and they might not?

Mr. Lisle. The expert who orders can see he has a good job. He can go to Lloyd's and get the records of every ship in the service and what she has done.

Senator Vardaman. How many ships of the type you speak of are now in the service?

Mr. Lisle. That is just about one firm I was speaking of?

Senator Vardaman. I mean this character of ship.

Mr. Lisle. In Lloyd's Register, vessels from about 100 tons to 15,000 tons show nearly 500, and then there are a large number, for instance, over 100 in Russia, which are not on the records.

As I was saying, the East Asiatic Co. have contracted with

Burmeister & Wain for another quarter million tons of Diesel motor ships up to 14,000 tons deadweight capacity each. They intimate that they have absolute faith in motor ships as a result of their six years' practical experience. Here, I might say, they took three steamships and installed Diesel motors in them. The rest of their steamships they sold during the war. Burmeister & Wain, the shipbuilders, of Copenhagen, Denmark, have entirely abandoned steamship construction, and now are building motor ships exclusively, and their orders for the North Star Line and for the East Asiatic Co. have booked their entire capacity for eight years ahead. There is not a steamship builder in the country who has orders for eight years ahead. I have a statement of their chief engineer in my grip.

Senator Nelson. I notice the biggest ships of this type are Danish. I guess over half of the lot in your album are Danish.

Mr. Lisle. Quite a lot of Danish and Dutch and Norwegian.

Senator Nelson. Swedish and Dutch and some Canadian and British, but I think over half are Danish.

Mr. Lisle. A considerable portion are Danish. It is reported that the Danish ministry of commerce has ordered 10 motor ships each of 2,500 tons deadweight capacity, from Burmeister & Wain, all to be completed within 18 months, provided the Government secures the necessary materials.

Holland, although acutely suffering from lack of shipbuilding materials during 1917, managed to launch 72 motor ships aggregatin 20,423 tons gross, or about 40,000 tons deadweight capacity, which represented a considerable portion of her total shipbuilding output, namely, 192,318 tons.

The Werkspoor Works, of Amsterdam, have constructed since 1908, or have under construction, engines for a total of 33 Diesel motor ships of 45,000 total indicated horsepower, and about 137,000 tons aggregate displacement.

Senator Vardaman. Let me ask you: Will this engine run a large ship as well as a ship of smaller size?

Mr. Lisle. Up to about 15,000 tons. It is rumored that Germany has a battleship, and I know before the war started she had commenced work on a 24,000 b. h. p. battleship and she got the first section of 6,000 b. h. p. completed.

Senator Vardaman. Why would they not run as large a vessel as a steam engine?

Mr. Lisle. Because there are mechanical troubles which they have not yet overcome in the designs of the engine, and which are being overcome as they go ahead. It is a question of gradual development.

The Chairman. The best cargo ship is between 8,000 and 10,000 tons?

Mr. Lisle. Yes; and you can get Diesel engines absolutely reliable for that.

Senator Vardaman. Is this a new invention?

Mr. Lisle. No; it is an invention nearly 20 years old, but was not developed for marine work to any extent until the patents expired. It is a German invention, and Dr. Rudolph Diesel is the inventor. But without the Diesel engine the submarine would not be possible. Every German submarine is Diesel engine driven, and those Diesel engines are of sufficient reliability to operate submarines, and the German Government never could build Diesel engines properly.

Senator Vardaman. Are we using Diesel engines in our submarines?

Mr. Lisle. Yes; and if they were not sufficiently reliable they could not carry out the present campaign. There are a large number of submarines all over the world, and they have never had any difficulty in finding men to operate those submarines, and yet the submarine engine is quite a complicated affair compared with merchant ship engines, as they have the problem of higher speed.

Among the Diesel engines for motor ships which Werkspoor now have building may be mentioned two of 9,700 tons, one of about 7,000 tons, and one of 4,050 tons for Otto Thoresen, the Norwegian shipowner of Christiania; also a 9,700-ton motor ship for Winge & Co., of Christiania, and one of 9,700 tons for the Ada Steamship Co.

It has been thought and stated by officials of the Shipping Board Corporation, I believe, that Diesel engine ships would delay the United States' shipbuilding program. This company in Holland designed, built, and ran trials of their first motor vessel in six months, and this was the first ocean-going Diesel ship ever built. Up to the end of last year she has run 210,000 miles. She was a vessel of 2,080 tons displacement, and now is in the Far East.

Sulzer Bros. of Winterthur, Switzerland, have been chiefly building naval type Diesel engines, but also have supplied some high-powered motors for tankships to the British admiralty, and other mercantile type motors. But, since they first commenced marine Diesel engine building, they and their foreign licensees have completed a total of 165,250 brake horsepower of merchantship type and submarine type motors and 238,070 brake horsepower of stationary type motors.

Now, altogether, that amounts to one-half million engine horsepower in marine and stationary Diesel engines, or equivalent to driving 161 ships each of 10,000 tons displacement deadweight capacity and of 12-knot speed. Therefore, there must be operators for those engines, even for land service.

Three of the principal merchant motorship builders of Italy are the Fiat-San Giorgio, Ansaldo & Co., and the Savoia Shipyard, all of which are controlled by Ansaldos, who have a capital of 100,000,000 lires. The Italian "emergency fleet" includes many motor vessels, and the Fiat-San Giorgio will launch not less than 18 standardized merchant Diesel motorships of 8,000 to 10,000 tons deadweight capacity each year, and, partly for this purpose 8,000 skilled workmen now are being withdrawn from the army, making a total of 18,000 to 20,000 men.

They have taken a big advertisement in our paper showing what they are doing in this country. They have already completed merchant-marine and submarine type Diesel engines to the extent of 90,000 brake horsepower, or sufficient propelling power to drive 30 freighters each of 10,000 tons capacity and of 12 knots speed. Recently they launched two Diesel tankships for the Italian navy department.

At Ansaldo's yard at Sestri Ponente, a number of standardized Diesel and steam-driven cargo ships of 8,100 tons deadweight capacity are under construction and at Ansaldo's Savoia yard two 6,000 tons deadweight capacity steel Diesel-driven auxiliary sailing ships are building. Ansaldo's, by the way, have a Sulzer license which they recently purchased.

It is reported that three Diesel-driven motor ships recently were launched at the Esercizio Bacini Co.'s yard at Genoa. I have not got any data of that, only just the report.

The firm of Franco Tosi, of Genoa, recently launched three Diesel tankships for the Italian Navy, and have started work on two more. They have been building naval craft, but will now build Diesel-driven merchant vessels. Franco Tosi, I think, is likely to make great strides in the construction of motorships, as they have done with high-powered submarines. Incidentally it may be mentioned that the Italian Government gives a subsidy of $25 per horsepower to owners of sailing ships who install motors in their craft, to encourage them to go ahead.

Recently the Japanese Government purchased a Diesel constructional license from Sulzer Bros. of Switzerland, and will build Diesel engines up to 2,400 horsepower each, and it is reported that it is their intention to place a fleet of motor-cargo ships on the Pacific Ocean, in which case it will be almost impossible for American steamships to compete with the Japanese on the Pacific Ocean under normal conditions; that is to say, our commerce on the Pacific coast, if we run steamships, will be wiped off unless the Government runs the business at a loss.

The Chairman. What would be the size of those ships?

Mr. Lisle. The size of those ships would be, I should say, 10,000 to 15,000 tons.

I have got a letter from the Sulzer Bros. saying that the Japanese Government paid them a very large sum of money for those drawings.

The Chairman. How about the speed of these Diesel engine ships?

Mr. Lisle. I should say it would be about 12 knots—11½ or 12 knots.

The Chairman. Can you get them faster?

Mr. Lisle. They can be constructed with a speed up to 15 knots, but you do not want freighters with that speed. I do not think there is any use of building 15-knot cargo ships. They will not carry so much cargo and they can not run away from submarines anyhow. The big German submarines they have out now develop 20-knot speed. I have a photograph of one right here [exhibiting photograph to the committee].

To continue about Japan, several Japanese shipyards also have purchased European Diesel engine rights, including the Kawaski Dockyard at Kobe.

Russia's inland waterway traffic does not concern America much, but on her lakes and rivers she has about 50 Diesel-driven tank vessels of about 5,000 tons capacity each, many large passenger motor ships, high-powered motors, tugs, and a dozen 1,000 brake horsepower Diesel gunboats in service. Here it may be mentioned that at Petrograd there is a splendidly equipped Diesel engine works where numbers of high-powered submarine and gunboat Diesel engines have been built. If Germany obtains control of this plant and of the Reval shipyard, it means at least another 50 big U-boats a year for Germany on the Atlantic.

About five months ago I foresaw this, and suggested to Secretary Daniels of the Navy that endeavors should at once be made to remove all the machinery from this great Diesel plant, to prevent the Germans obtaining control, but have not heard if it was possible to do this. If Germany obtains control of the Kolomna Diesel Works, Soromow Diesel Works, and the Nicolaieff Shipyard, we also can expect renewed submarine activity in the Mediterranean next winter.

The thing is, will they get control of those yards? I do not know. You are familiar with the real situation in Russia. I am sure I am not.

The Chairman. Would there be any trouble getting fuel if we adopted that type for future construction?

Mr. Lisle. None whatever. The United States is the greatest oil country in the world, and we should use that oil to drive our ships. The crude oil is found in all parts of the United States, especially California and down in Texas. But the point is, you see, if you build oil-firing steamers, they use three times the amount of fuel when burning oil under the boilers instead of coal. If coal, it is five times the amount.

The largest merchant vessel ever built in Sweden, the "Bullaren," is a Diesel driven motorship. She is the first of three sister cargo ships of 9,100 tons capacity and 4,000 indicated horsepower building for the Transatlantic Co., at the yard of the Gothenburg Shipbuilding Co. Her Burmeister & Wain motors were built under license.

Another Swedish Diesel engine company, namely, the A. B. Diesels Atlas Motorer of Stockholm, have a fully paid capital of five and one-half million dollars. They have engined dozens of coastwise vessels and two ocean-going motor ships, one of which, the "Hamlet," a 10,000-ton vessel, regularly calls at Philadelphia.

Norwegian shipowners are building many motor ships and auxiliaries. In fact they have been responsible for most of the moderate-sized motor ships and auxiliaries lately built in the United States. You know we have had a number of those that have been built in the United States, and most of these orders were placed by the Norwegians. The Akers shipyard have a Burmeister & Wain Diesel license, and are building big motor vessels for trans-Atlantic service.

The largest vessel ever built in Norway was a motor ship, a freighter of 6,500 tons deadweight capacity, recently launched at the Akers yard for Fred Olsen, who has several more under order.

France has not very many. Before the war only a few large motor ships had been completed, one of which was an unusual craft, being a high-powered auxiliary steel sailing vessel of 10,500 tons displacement, which has been very successful. Apparently they have been devoting their attention to naval work since the war.

The Spanish Government about a year ago encouraged domestic concerns to build marine Diesel engines by intimating that they would give large orders to concerns which would buy European licenses. The Spanish Engineering & Metal Co., of Madrid and Balboa, lately acquired a Sulzer-Diesel license. At another Spanish shipyard, in Barcelona, Diesel-driven concrete motor ships of 450 and 1,500 tons are being built, while the Valencia Shipbuilding Co. have laid down some 450-ton wooden auxiliary sailing ships.

The well-known Compania Transmediterranea has plans well in hand for a shipbuilding and engineering works at Valencia, and four shipways for vessels up to 10,000 tons displacement are being arranged for. The new machine shop will build the internal combustion motors for these ships.

The Chairman. What is the necessity of buying a license from Switzerland?

Mr. Lisle. To save the trouble of developing for themselves. It is not only from Switzerland that that is done; you can buy a license from Holland, Denmark, or England—for whichever engine you like.

The Chairman. They are of different types?

Mr. Lisle. Different types and different designs; they each have their own ideas, and they go ahead on them.

Senator Vardaman. What do they cost?

Mr. Lisle. The licenses?

Senator Vardaman. Yes.

Mr. Lisle. Not very much. The New York Shipbuilding Co. and the Newport News Shipbuilding & Dry Dock Co. both purchased Werkspoor licenses from Holland. They have all the drawings, and everything; and they go ahead with them as they want.

Senator Vardaman. How are the licenses paid for?

Mr. Lisle. Partly cash and partly royalty; a cash payment of so many thousands of dollars, and a royalty of so much per horsepower; and then they buy the drawings extra.

William Cramp & Sons Ship & Engine Building Co. have a Burmeister & Wain license; and various companies throughout the country have licenses.

With regard to Great Britain, that is distinctly a coal country; and as she has bunker-coal stations all over the world, it perhaps may be considered to her advantage to build coal-fired ships during the war, especially as there is a shortage of tank ships.

Yet there is hardly a shipbuilding company of note in Great Britain which has not purchased some well-known European marine Diesel engine license, such as the Burmeister & Wain, Sulzer, Tosi, Fiat, Werkspoor, Polar, M. A. N., or Carels; and before the war about one dozen large British motor ships were completed.

For instance the Glen Line have four 10,000-ton deadweight capacity motor ships in service, four sister vessels on order with Harland & Wolff; and it is reported that they have contracted with the same shipbuilders for 20 more of these standardized 10,000-ton ships. Lord Pirrie, the head of that company, has just been appointed comptroller of British shipbuilding; and so, personally, I think that before long we shall see many standardized motor ships being built in Great Britain, because, judging by his actions, Lord Pirrie has shown himself to be a believer in the motor ship.

Senator Vardaman. Have you discussed this matter with the Emergency Fleet Corporation?

Mr. Lisle. I have taken the matter up with them a number of times, and made suggestions that they adopt a standard form of Diesel motor ship.

Senator Vardaman. Have they done nothing about it?

Mr. Lisle. They have done nothing whatever. Theodore Ferris was very strong against them; he did not believe in them; he did not know anything about them; he had not made proper studies. And they relied on him in the past as an expert; and I think they have been so busy since then, and have had so many troubles that they preferred to go ahead on lines that they knew about.

The Chairman. Your suggestion, as I understand, is not to interfere with the present program of the Shipping Board or Fleet Corporation in any way, but that in future construction the motor ship should be considered?

Mr. Lisle. Yes, sir; take the matter up right away. There are people in the country building these engines now. One big plant in Milwaukee, Wis., has been building a number of these Diesel engines, of quite a large size, 1,200 horsepower; and all of their experience in building engines of that kind has been wasted, because they have now been given an order by the Emergency Fleet Corporation for 15 marine steam engines of 1,400 horsepower. That is a wicked shame to waste their experience and equipment in that way.

I have a telegram here from the publishers of our paper, Motorship, in Seattle, which says:

"Dr. Luckie of Columbia University was here last week, and he thinks it criminal that American oil engine factories should be working at building steam engines for the Government."

I understand that a number of these firms have approached the Shipping Board for orders, but they have not been able to get any.

The Chairman. Are there many firms equipped to build Diesel engines in this country?

Mr. Lisle. Quite a number; but they have not developed any large sizes, except one concern, and that is for stationary engines. But there is no reason why they can not go ahead and expand their works. You might say that there were no concrete shipyards; but you are going ahead and building concrete ships.

The Chairman. This motor power—the Diesel engine—can be installed in almost any ship, can it?

Mr. Lisle. Yes, sir; in almost any ship. It is a wonderful thing, and we ought not to ignore it.

The Chairman. Do you think they could be built to any extent in this country?

Mr. Lisle. Without any doubt; because you can get all the expert assistance you want from abroad; they will send men here, and will furnish all their drawings.

The Chairman. And then men will have to be provided to operate the boats?

Mr. Lisle. The men to operate them can be provided while the engines are being built. Look at the number of chauffeurs there are in this country; you can take them from all over the country and put them in the shops. They have a smattering of mechanical knowledge; and they can be doing good work along that line while they are learning to operate those ships. They will get sea sick while they are learning to operate the boats, but that will not last very long.

Apart from the large motor ships that I have referred to there are dozens, or rather, hundreds, of small wood, steel and concrete coastwise motor craft under construction in all the different countries. Most of these are fitted with oil-engines of the surface-ignition type. In fact, practically all concrete ships building in Europe will be motor-propelled.

Senator Vardaman. Well, I hope you will give all the information you have to the Emergency Fleet Corporation.

Mr. Lisle. I will pass this information along to them.

Senator Vardaman. Yes; of course, those practical questions they have to work out.

Mr. Lisle. Yes. These [exhibitiing photographs] are the different types of the domestic and European Diesel engines. That [indicating] is a 6-cylinder engine.

The Chairman. It looks like a complicated piece of machinery.

Mr. Lisle. It is not really complicated; it is all a duplication; there are six cylinders, you see, and every one is the same as the others.

Senator Vardamann. I suppose it is not complicated to the man who understands it?

Mr. Lisle. No; I agree that it may seem complicated to the layman. It does not seem complicated to me. I am an engineer myself.

This [indicating photo of Winton engine] is more the type of engine that has been built in the United States; they are lighter, higher-speed engines. McIntosh & Seymour, at Auburn, N. Y., have a fine type, and they could take orders on; they would have to extend their equipment, of course.

The Chairman. Is that all you have to say, Mr. Lisle?

Mr. Lisle. That is all, Mr. Chairman.

The Chairman. We are much obliged to you, sir.

NEW AMERICAN DIESEL-DRIVEN TANKER.

Now under construction in this country is a Diesel-driven tanker for a prominent American oil company, and which before long will be in service. The following are her dimensions:

Length b. p., 208 ft.
Breadth m., 35 in. 6 in.
Depth m., 17 ft. 3 in.
Draft loaded, 15 ft.
Deadweight-capacity, 1,800 tons.
Power, 500 shaft h. p.

This motorship is being equipped with a six-cylinder, four-cycle type, direct-reversible McIntosh & Seymour Diesel heavy-oil engine of 500 b. h. p. at 185 r. p. m. of similar design to that described and illustrated in "Motorship" for January last. The auxiliary machinery of this vessel will be steam-driven, power being furnished from a donkey-boiler.

First Dow-Diesel Engined Motorship---the "Libby Maine"

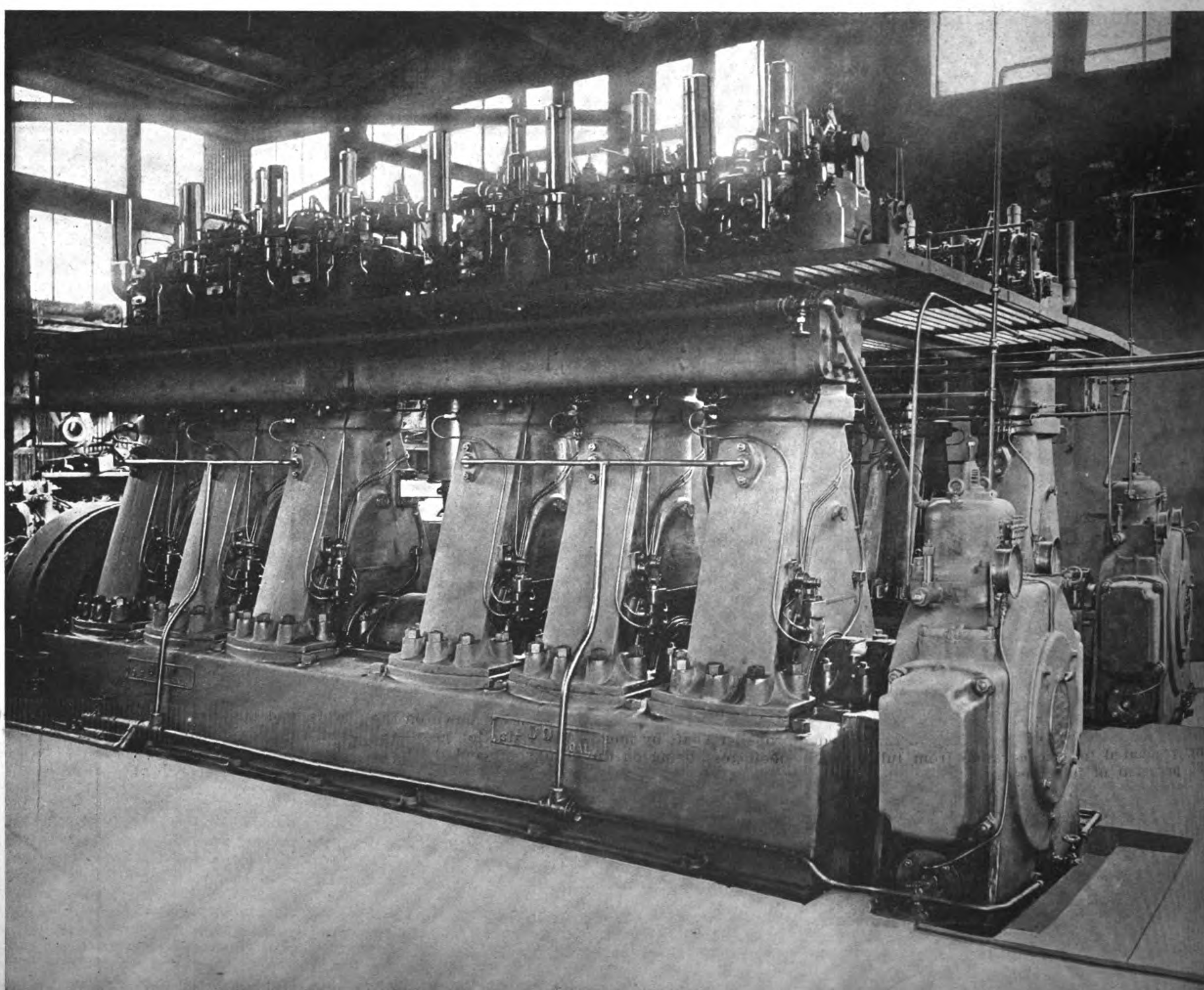
THE launching of the motorship "Libby Maine" on March 26, marks the completion of the first vessel to be equipped with full-Diesel engines of the Dow-Willans type manufactured by the Dow Pump & Diesel Engine Company of Alameda, Cal. It also marks the completion of the third oil-engined vessel from the yards of the G. M. Standifer Construction Company of North Portland, Oregon. The launching was very successful from every side; the ship taking the water without any trouble. Mrs. D. W. Branch, wife of the manager of the Salmon Department of Libby, McNeill & Libby, the owners of the vessel, acted as sponsor. The performance of the "Libby Maine" will be eagerly watched by all those interested in marine oil-engines.

The main engines of the "Libby Maine" were manufactured as has been stated at the works of the Dow Pump & Diesel Engine Company, at Alameda, Cal., where this company for a number of years have been manufacturing a very successful type of stationary Diesel-driven oil engines, being the only United States licensee of Willans & Robinson of Rugby, England. In building their marine engines the Dow people have maintained the principal features of the Dow-Willans stationary type and have altered and added such parts as are necessary to make it adaptable for marine use. In general it may be said that there are no structural differences other than the addition of extra cams, levers, etc., required for the reversing feature.

The engines of the "Libby Maine" are of the four-cycle, six-cylinder type, 12"x18", which generate 320 b. h. p. or 428 i. h. p. at 250 r. p. m. giving an estimated speed to the vessel of 8 knots. They are of the A-frame type, with special oil-tight guards to the crank pits, which while enclosing the oil, can readily be removed for inspection of the crank-pin, and cross-head pin without stopping the engine. As long trunk pistons are used the makers decided not to use crossheads and guides, which they think to be unnecessary in this type of piston, preferring to obtain the advantage of limiting the total overall height and weight of the engine to a minimum. The cylinders have separate cast liners following accepted practice.

The cylinder heads are detachable and carry the brackets that support the rockers for operating the valves. On a level with the cylinder heads is the camshaft which carries both sets of cams for ahead and astern motions of the engine, this

THE "LIBBY MAINE" LEAVING THE WAYS



OUTBOARD SIDE OF THE DOW-WILLANS STARBOARD ENGINE TO BE INSTALLED ABOARD THE "LIBBY MAINE"

method eliminating the use of short or long push-rods, the cams operating the hardened steel rollers of the rockers direct without any intermediate mechanism. The cam-shaft is driven by enclosed helical gearing from a vertical shaft the lower end of which is operated off the main crank-shaft at the forward end of the engine. On this vertical shaft is mounted the governor and eccentric for driving the fuel-oil pump. Here is a feature which gives evidence of careful study of the best European practice for they have adopted a single fuel-pump for all cylinders, instead of individual pumps for each cylinder, the latter system requiring very delicate adjustment, whereas by fitting one large pump, regulation becomes a very simple task. It is a constant stroke single-plunger model with a very sensitive regulation device giving, it is claimed, great accuracy in control. Incidentally it may be said that the by-pass system of regulation has been abandoned by them. There are three fixed positions for each control lever, namely, starting, stopping and full speed, the intermediate positions from stop to full speed being graduated to give a range from full speed to 35 per cent of full speed.

Governing is by the Dow improved centrifugal type and operates directly on the supply of fuel-oil to the injection-valves, in proportion with the load; at all times retaining the predetermined revolutions. It is mounted on the vertical shaft which drives the cam-shaft, is enclosed and is furnished with a hand-control device. The minimum pressure for starting these engines is about 200 lbs. per sq. in., but for general practice the pressure used will be a little higher.

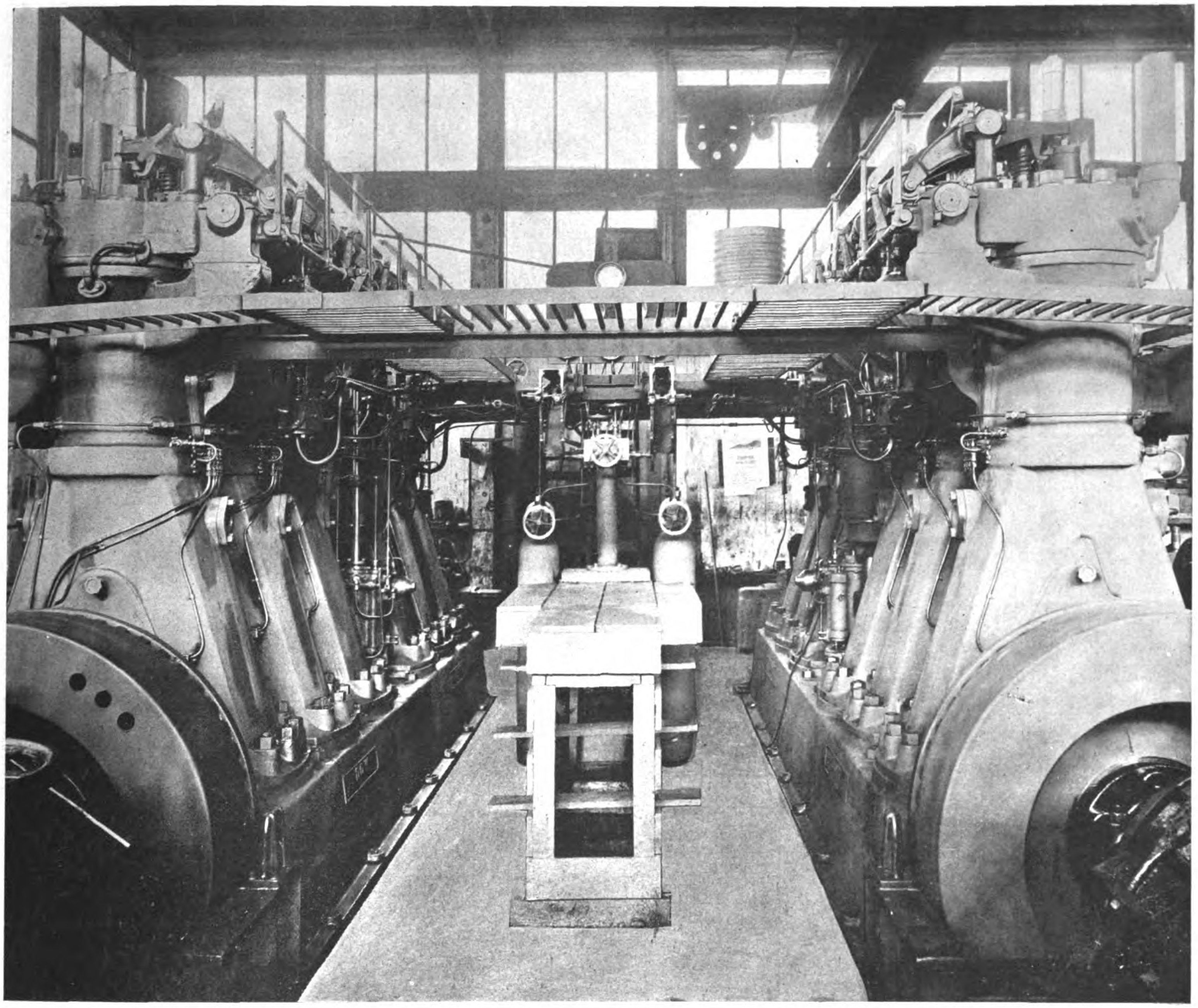
On the test blocks at Alameda these engines were started from cold to full speed in 6 seconds and changed from full speed ahead to full astern in the same time. The fuel consumption on a 72 hour continuous test showed at b. h. p., .412 lbs.; at i. h. p., .3108 lbs., on 16 gravity oil. During the tests the engines had absolutely no bearing trouble nor did they have hot crank pins or cylinders, according to L. A. Braddock, the chief engineer of the "Libby Maine," who became thoroughly acquainted with the engines while in the shop. The speed of the engines has been stated as 250 r. p. m., but this has been cut down on the propeller shaft by means of a reduction gear—the small gear being on the crankshaft and the large gear on the intermediate shaft that goes to the propellers. This turns the wheels at a speed of 100 r. p. m.

While this is the first marine engine made by the Dow people everything tends to indicate that it will be a success. Experience of other builders coupled with the advantages of a very complete shop and an efficient staff of engineers will soon show results in this and following installations.

The auxiliary machinery will consist of an 80 h. p. Standard engine for generating electricity for the deck winches, a 30 h. p. Standard for the air-compressors, the auxiliary air-pumps and the fire and bilge pumps. A 10 h. p. Standard will be used to generate power for lighting and a 5 h. p. Standard will be located on deck for the wireless and emergency lighting.

The other vessels built by the G. M. Standifer Company are the "W. F. Burrows" a Skandia engined vessel owned by Libby, McNeill & Libby from Seattle to Bristol Bay, Alaska, and the "James Timpson," a Winton powered ship.

The "Libby Maine" is 240 feet long, 43 feet wide, and has a moulded depth of 24 feet, giving her a dead weight capacity of approximately 2000 tons. She will be used in the general freighting trade between the company canneries and Seattle. She will be in command of Capt. E. Herre.



THE TWIN 320 B. H. P. DOW-WILLANS ENGINES ON THE TEST BLOCKS AT THE DOW PUMP & DIESEL ENGINE COMPANY'S PLANT, ALAMEDA, CAL., BEFORE SHIPMENT

NEW CONCRETE MOTOR CRAFT.

A new system of construction has been used in the case of a little motor-vessel built by the Cubitt Concrete Boat Building Co., of Chiswick, London, England. The timber frame and cast was eliminated, and the concrete was moulded on sheets of expanding metal to a thickness of 1¾". The vessel is 40 ft. long by 8½' beam and 4¾' draft, and will carry 20 tons of cargo at about 7 miles an hour. The weight complete, including iron keel and a 25 h. p. motor, is 8¼ tons (2,240 lbs. to a ton.)

MINISTER OF MERCHANT SHIP BUILDING.

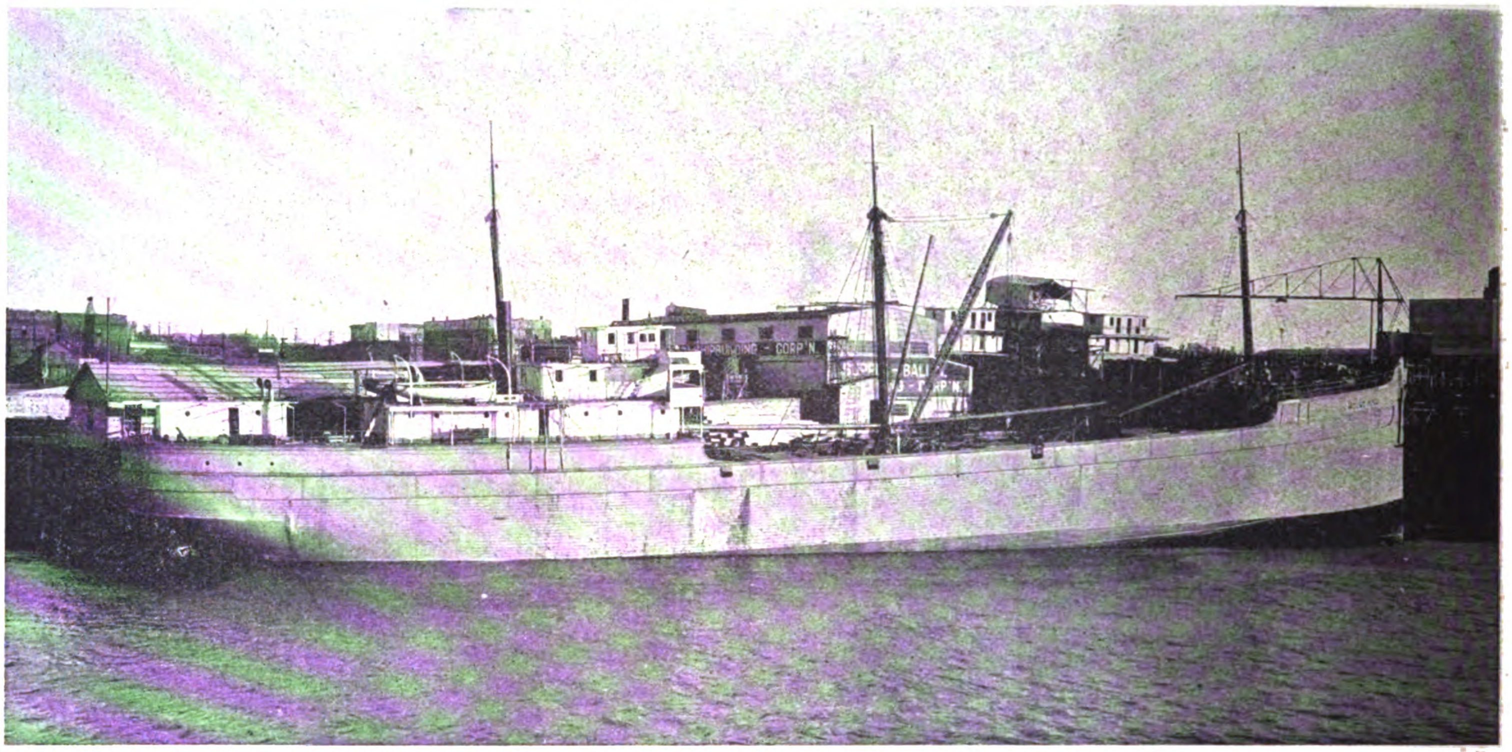
Lord Pirrie, on whom a personality article appeared in the February issue of "Motorship," has received an offer from the British Government to take the post of Minister of Merchant Ship Building. It is expected that he will accept.

CONVERTED SAILING SHIPS.

Bolinder oil-engines have been installed in the steel sailing ships "Gladys," and "Dolbadarn Castle," owned by the Asiatic Petroleum Co., the work being done in China by the Hong Kong & Whampa Dock. They also were converted at the same time from barks to barkentines. The "Gladys" is of 1,363 tons gross and was built at Bristol, England, in 1891, while the "Dolbadarn Castle" was built in Scotland in 1897 and is of 1,989 tons gross.

The Full Powered Motorship "Mount Hood"

"MT. HOOD" and "Mt. Shasta" are the names of the two wooden full-powered motorships recently completed at the yards of the Supple & Ballin Company at Portland, Oregon. They are twin vessels, each being 308′ o. a., 44′ 6″ beam, and 26′ moulded depth, giving them a carrying capacity for 4655 tons d. w. on a freeboard of 4′ 5½″ (assigned by the American Bureau of Shipping.) These figures make these vessels the largest full-powered wooden motorships yet built. Each is equipped with two 8-cylinder, full Diesel, four-cycle type, Winton Diesel engines, built by the Winton Engine Works of Cleveland, Ohio, which generate their rated power of 500 b. h. p. each at 250 r. p. m. The installation aboard the "Mt. Hood" has been completed and the ship is now awaiting her trials. The "Mt. Shasta" will run her trials about the 15th of April. A speed of 8½ knots is expected by the owners Gaston, Williams & Wigmore of New York City. These vessels are, according to Mr. Fred Ballin, one of the builders, the lightest wooden vessels in proportion to their size yet built in the Columbia River or any other region. They are planked diagonally and have steel topside reinforcements.



THE MOTORSHIP "MOUNT HOOD"

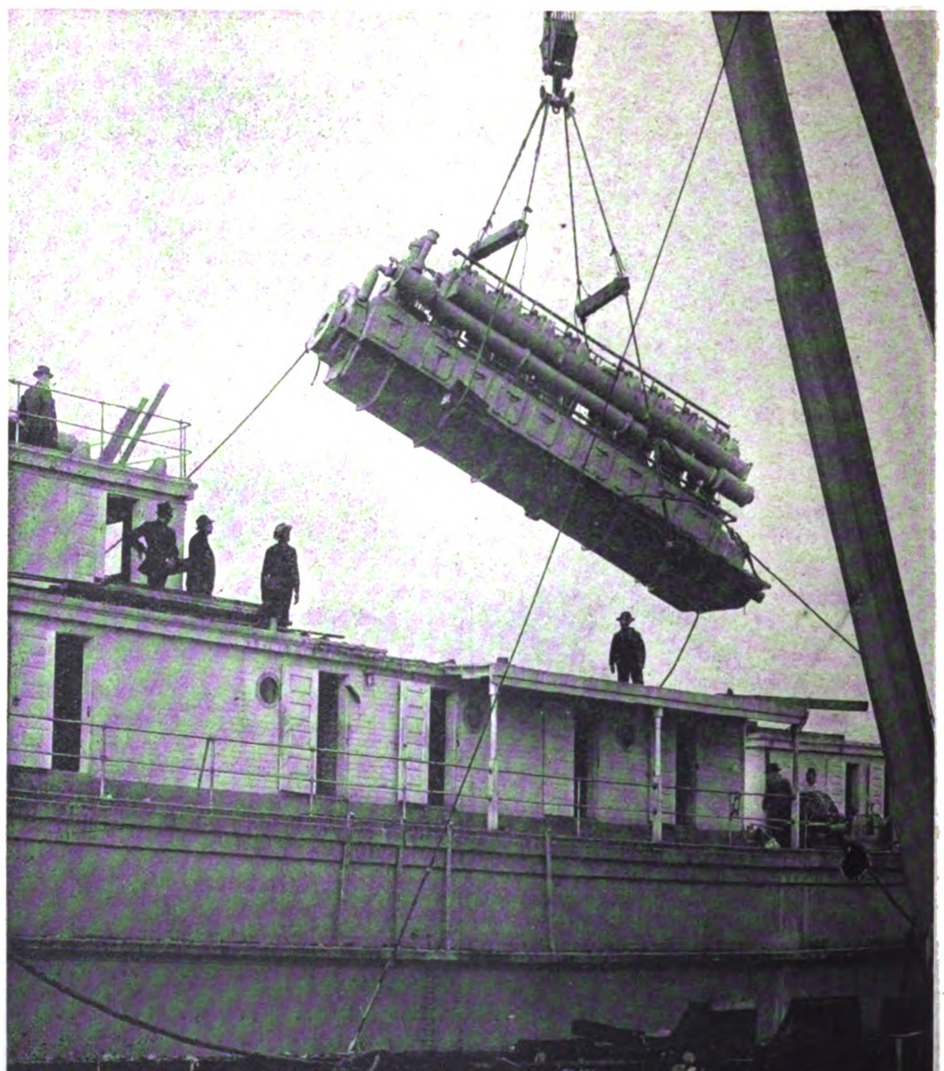
The main engines are of the four-cycle type, are direct reversible and are of the single acting class. They have eight cylinders each 12 15/16″ bore by 18″ stroke. Although this engine is rated at 500 b. h. p. it can be developed to above 600. Starting air for these engines ranges from 600-900 lbs. pressure and the pressure of the fuel injection pressure varies from 450 lbs. Reversing can be accomplished from full ahead to full astern in four seconds. This reversing is accomplished by means of sliding cam shafts which are moved fore and aft bringing a second set of cams under the rollers of the valve-rockers, the sliding motion being effected by a simple ratchet actuated by the control wheel. The compressors are of the three stage type and are gear-driven. The starting air-compressor is two stage and is driven by steam supplied by an oil-fired donkey boiler of 1000 sq. ft. heating surface, made by the builders of the vessel.

The tanks for the lubricating oil will contain about 2000 gallons. The oil is pumped through separate oil filters for each engine and from the filters it passes through oil coolers to pumps on the main engine which deliver the oil to the lubricating system under a pressure of about ten pounds. The fuel for the main engines is carried in 8 tanks with a total capacity for 2000 barrels. All the fuel is pumped to gravity tanks before feeding the main engines.

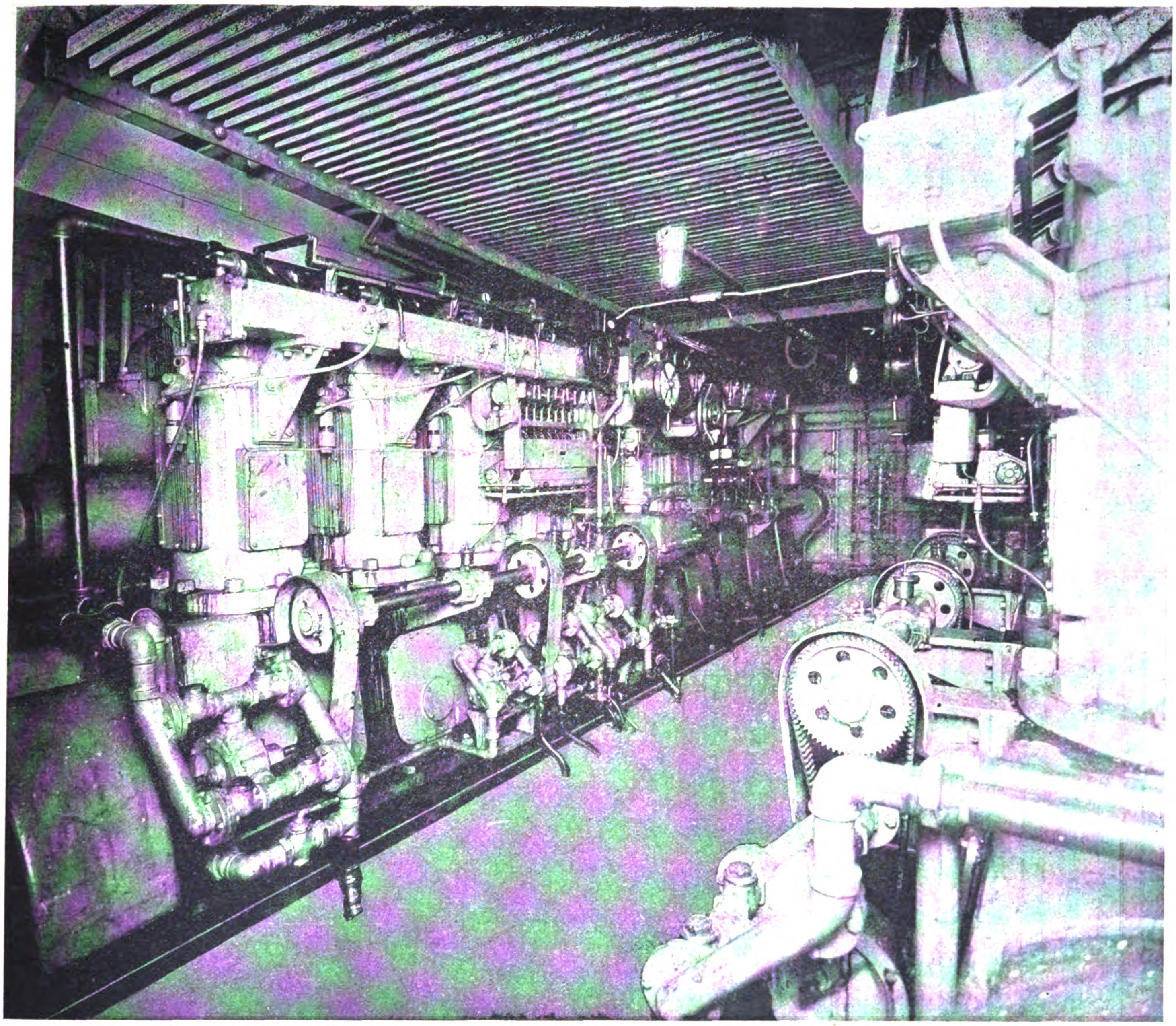
The donkey boiler also supplies power for the winches and windlasses and is connected to the main fire and bilge pumps located in the engine room. All pumps are worked with air supplied by the compressors.

In the engine room are also two Fairbanks-Morse direct connected electric power units, one 20 b. h. p. and the other 10 b. h. p. These give power for the bilge, circulating and cooling pumps, for the steering gear, refrigerating machinery and for the ship's light. The steering gear is of the Supple & Ballin electric type.

These vessels together with the "Erris" and the "Esperanca," two vessels built by the Peninsula Shipbuilding Company, of Portland, and the "James Timpson" recently completed by the G. M. Standifer Construction Company, of Portland, make a total of five Winton engined vessels to be constructed on the Columbia River within the last year. (See opposite page for illustrations of the Mount Hood's marine engines and auxiliaries).



LOWERING ONE OF THE "MOUNT HOOD'S" ENGINES INTO THE VESSEL



OPERATING SIDE OF "MOUNT HOOD'S" 500 B. H. P. PORT WINTON DIESEL ENGINE, SHOWING FUEL PUMPS AND CHAIN-DRIVEN OIL AND WATER PUMP

TESTS OF A 600 B. H. P. DIESEL ENGINE.

In the issue of March, 1917, we gave drawings and details of the Sulzer-type of experimental two-cycle Diesel engines built by Nobels of Petrograd, Russia, and installed in the M. S. "Imperatriza Alexandra," each of which were rated at 600 b. h. p. We now are enabled to give some data made at the shop tests of these two motors:

Duration of trial, mins.	60	30	30	30	30
R. P. M.	211	200	206	175	250
M. E. I. lb. per sq. in.	69	81	38.5	38 5	72.5
B. H. P.	598	667	326	276	749
I. H. P.	772	849	504	412	981
Mechanical efficiency, percent.	77.5	78.5	64.7	67	76.3
Thermal efficiency, percent.	31.4	30.6	28.5	28.8	29 5
Fuel consumption per b. h. p. hour	.442	.454	.490	.486	.474
Temp. of cooling water inlet, deg. F.	48.2	48.2	48.2	48 2	48.2
Temp. of cooling water outlet	98.6	104	86	78.8	91.4
Temp. of exhaust gases	532	608	356	320	669

Lubricating-oil consumption (cylinders), 0,00663 lb. per b. h p. hour.

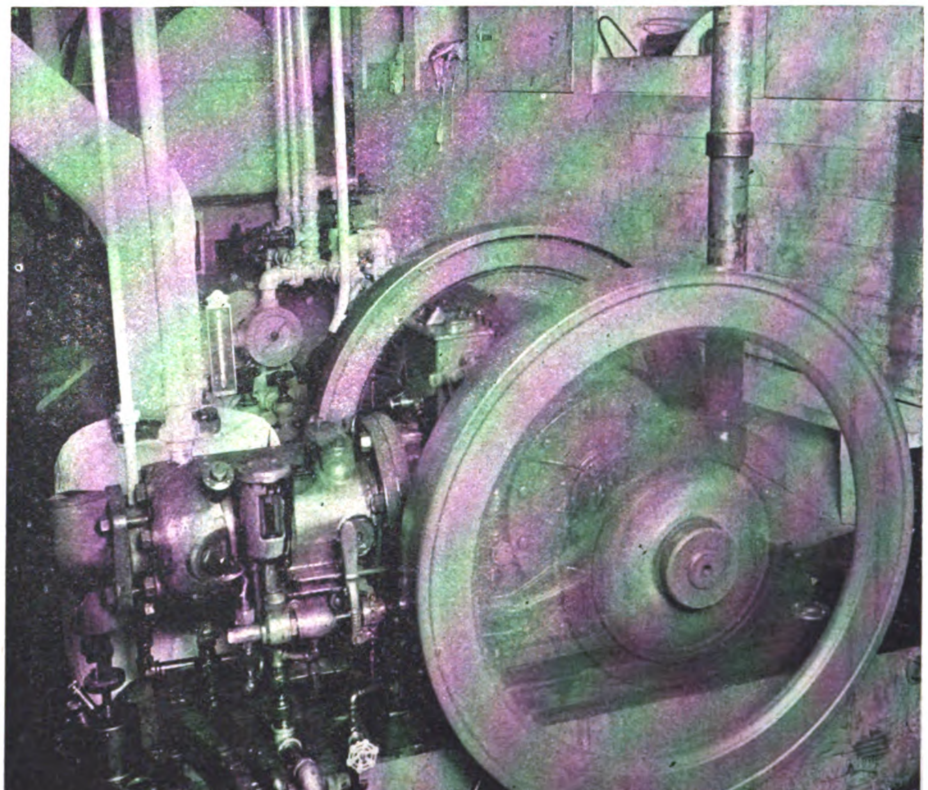
Fuel used, Russian crude naphtha.

Specific gravity of fuel, 0.855 at 15 deg. C.

Heating value of fuel, 18,000 b. t. u. per lb.

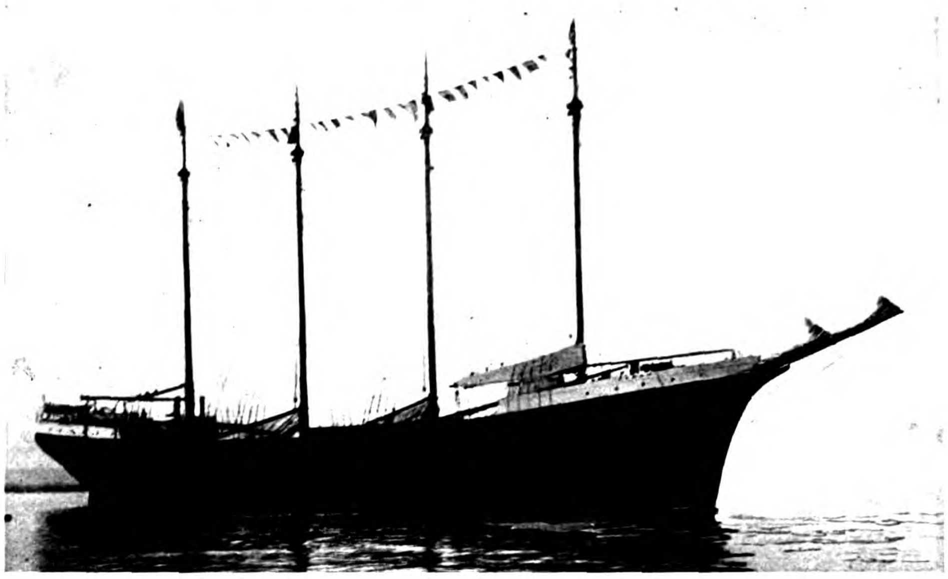
MOTOR FIREFLOAT.

For Sir Wm. Armstrong Whitworth & Co., the Diesel engine and ship builders of Elswick, England, a motor firefloat has recently been completed by Merryweather & Sons of Greenwich, London. The little vessel is 63 ft. long and has two gasoline motors of 70 b. h. p. for propelling and pumping purposes.



20 B. H. P. FAIRBANKS-MORSE POWER UNIT FOR GENERATING POWER FOR THE LIGHTING AND REFRIGERATING MACHINERY OF THE "MOUNT HOOD"

The Motor Auxiliary "Ypres"

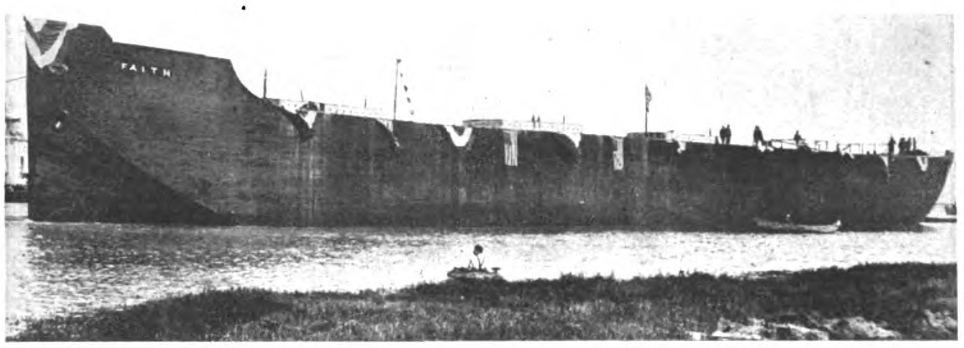


THE "YPRES" DIRECTLY AFTER THE LAUNCHING

THE above photograph is that of the "Ypres" the launching of which was described in the February issue of Motorship. The "Ypres" is the fourth Skandia engined vessel to be launched from the yards of the Puget Sound Bridge & Dredging Company for the account of the Washington Shipping Corporation. These vessels were all built for the French Government, and were powered with two 240 b. h. p. engines.

The "Ypres" loaded a cargo of flour at Seattle, and set sail for France, February 20, under command of Capt. S. B. Shaw.

Largest Concrete Ship Yet Launched



THE "FAITH"

A real ship is the concrete ship "Faith," which was launched at Redwood, Cal., at the yards of the San Francisco Shipbuilding company's plant. Her displacement is of 7,900 tons and her carrying capacity 5,000 tons. She is 320 ft. b. p. by 44.6 ft. wide and 30 ft. deep on a loaded draft of 24 ft.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, of Motorship, published monthly at Seattle, Washington, for October 1st, 1917.

State of Washington, County of King, ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Russell Palmer, who, having been duly sworn according to law, deposes and says that he is the manager of the Motorship, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to-wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Miller Freeman, 2606 Smith Bldg., Seattle, Wash.; Editor, Russell Palmer, 2602 Smith Bldg., Seattle, Wash.; Business Manager, Russell Palmer, 2602 Smith Bldg., Seattle, Wash.

2. That the owner is: Miller Freeman, Seattle, Wash.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

RUSSELL PALMER,
Business Manager.

Sworn to and subscribed before me this 12th day of October, 1917. (Seal) E. J. BROWN,
(My commission expires August 12, 1920.)

FERRO-CONCRETE SHIPS.

(Continued from Page 10.)

the case now stands, one might be tempted to say that the consideration of weight would not place any upward limit to the size to which ferro-concrete vessels may be built. There is, however, another important consideration which comes into play, viz., that of comparative cost, which has now to be inquired into.

VII.—Cost of Ferro-Concrete Ships.

The saving which can be effected by ferro-concrete in a certain closs of vessel is due partly to the saving in steel, partly to the fact that no heavy plant is required for ferro-concrete work, and partly to the fact that the bulk of the labor employed need not be skilled, and is therefore cheaper. But if the last two factors remain the same whatever the size of the vessel the first is a variable one. To start with it must be stated that the saving in steel is not as great as was wildly claimed at first by superficial designers who had not grasped the difficulties of the problem, a saving of 80 per cent or even more as has been mentioned occasionally seems quite out of the question. Nevertheless saving exists and in some cases exceeds 50 or 55 per cent which is not at all negligible. And in that respect it is as well when comparing figures to note that in ferro-concrete there is no waste of steel in the process of construction whereas it seems a recognized fact the weight of steel required for building a steel ship is about 10 per cent greater than that of the steel which is finally embodied in the structure owing to waste in cuts of plates, angles, rivet holes, etc. As far as stresses go steel is not used very economically for steel ships of small tonnage, but it receives a better utilization when the tonnage grows. By way of illustration, taking as units the stresses per square inch on the upper deck and on the bottom plating respectively for steel cargo vessels of 1,000 tons deadweight it may be assumed that the stresses in bigger vessels would approximately be greater in the ratio shown in the following Table IV.:

Table IV.—Ratio of Increase of Stress Tons per Square Inch.

Deadweight in tons	1,000	2,000	3,000	4,000	5,000	6,000
On upper deck........	1	1.18	1.33	1.44	1.54	1.64
Bottom plating	1	1.22	1.40	1.58	1.75	1.94

It will be seen that steel vessels have to meet the same difficulty as ferro-concrete vessels in the case of small tonnage, viz., a bad utilization of the full strength of the constituent materials. Whereas, however, in the case of ferro-concrete it is the concrete which is badly utilized (as far as its potential strength is concerned), in steel vessels it is the steel. In both cases the drawback gradually disappears when the tonnage increases.

A much better utilization of the steel takes place in ferro-concrete ships of small tonnage, utilization which cannot be improved upon very much when tonnage increases. It would seem that the important saving in steel resulting from the adoption of ferro-concrete for ships of small tonnage remains a fairly constant percentage up to say 3,000 tons deadweight, but in the light of present designing that for larger units it would become gradually smaller.

It is most difficult to give an accurate comparison of the prices for steel and ferro-concrete ships. The question is so beclouded by considerations of many kinds that it has been questioned whether the undeniable advantage which ferro-concrete offers today in this respect will remain when normal times return. The author feels unable to give precise indications which actual experience may alone procure. But it seems fair to say that on a pre-war basis one may estimate that the cost of the ferro-concrete hull is about 70 per cent of the cost of the steel hull of same deadweight carrying capacity in the case of small tonnage, the saving becoming somewhat less important for bigger units. As against this one may set up the fact that the cost of machinery and outfit for concrete vessels is approximately 5 per cent dearer than it is for steel vessels.

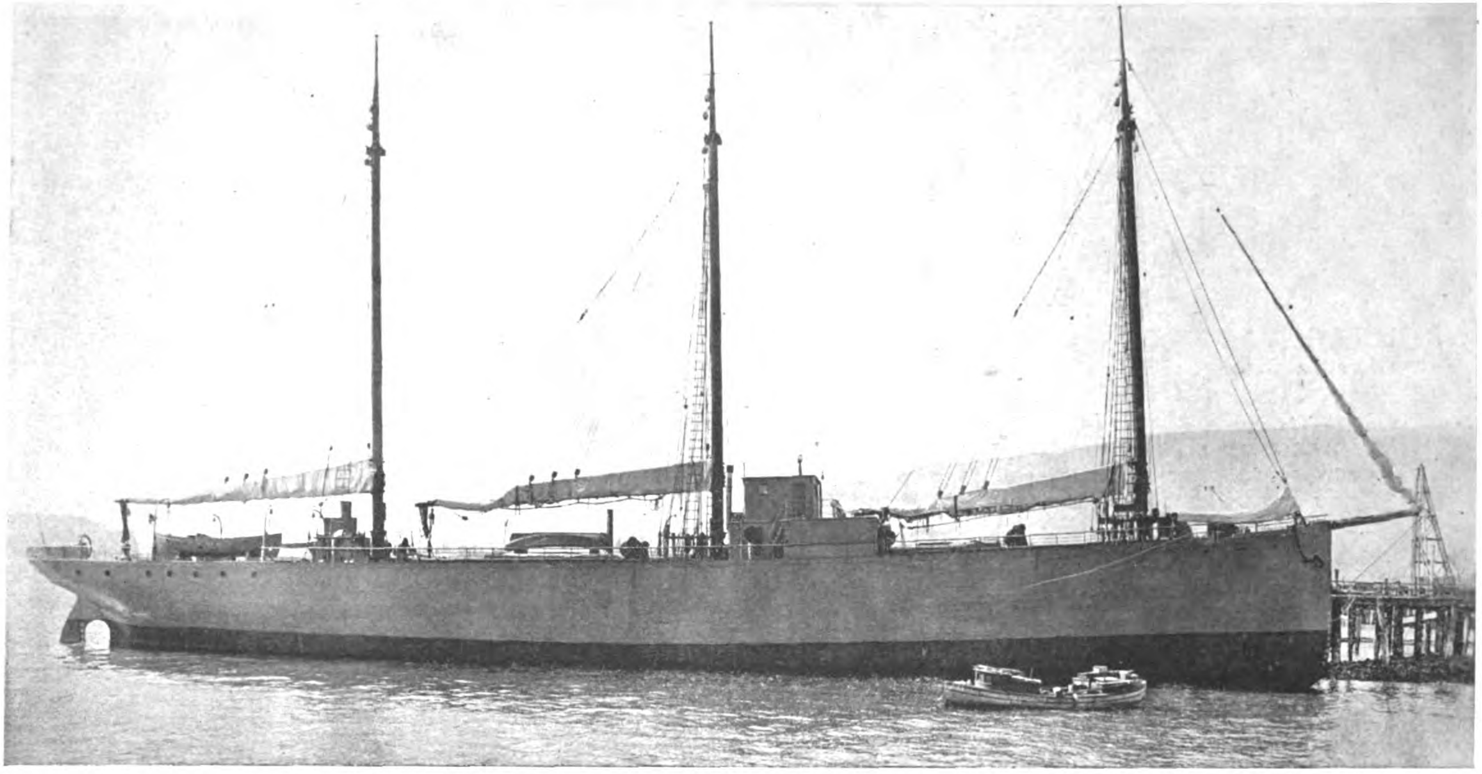
In conclusion the author wishes to apologize for the limitations of the paper and its shortcomings, of which none is more aware than himself, and to express his thanks, in addition to the persons named above, to the members of their respective staffs, whose help has been invaluable to him during his study of that most intricate and difficult question—ferro-concrete ships.

THE "GERMANIA" TO FLY STARS AND STRIPES.

The Kaiser's old Diesel-engined auxiliary yacht "Germania," ex "Meteor III" recently was purchased by Capt. Hans Hannevig for $50,000. The purchase was made on behalf of that well-known New York shipowner and banker, Christopher Hannevig, who will use her here. In connection with the purchase, a gift was made by the Hannevigs of $25,000 to the British Red Cross Society, and $25,000 to the French Red Cross Society.

The Motorship "Bowler," ex Steamship "Zafiro"

Admiral Dewey's Collier Changes From Steam to Diesel Power



THE MOTORSHIP "BOWLER" LAYING AT THE DOCKS AT VANCOUVER, B. C.

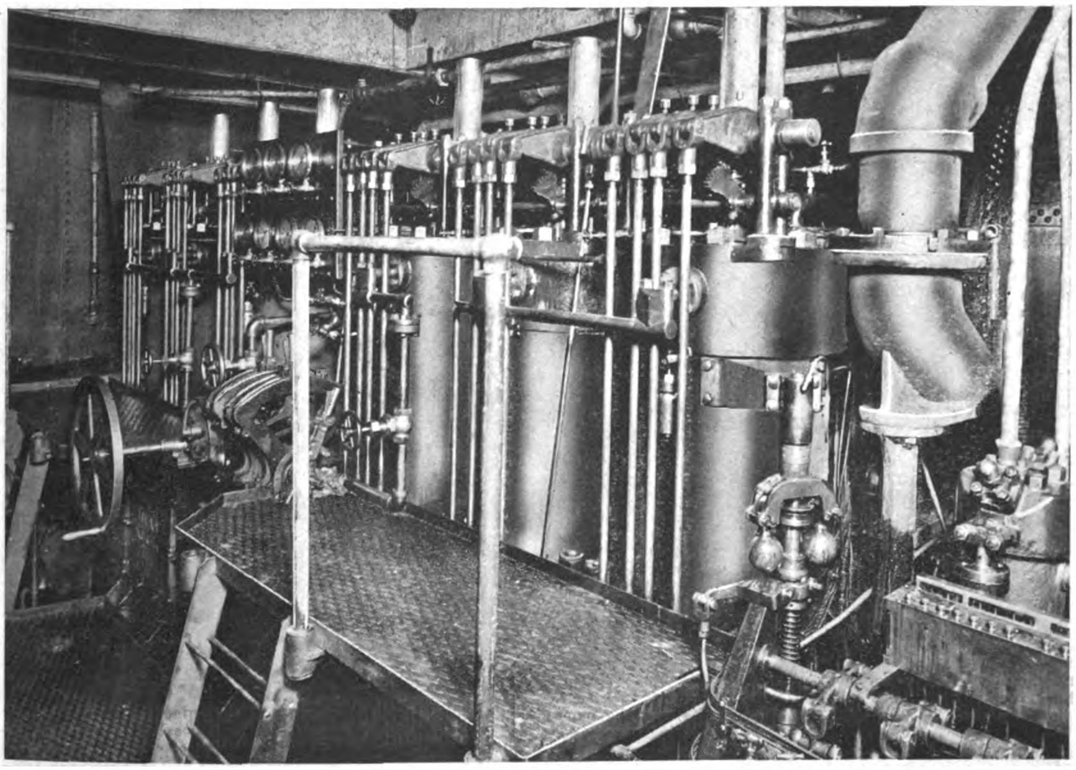
The freighter "Zafiro," which has been re-christened the "Bowler," and which has been laid up at the docks at Seattle, Wash., and Vancouver, B. C., for a number of years, has been completely overhauled, remodelled and has had installed within her a set of Diesel type engines, making her a full-powered motorship, ready to take the seas and to do her part in supplying our Allies with food and other supplies. The period of regeneration of the "Zafiro" extends over a period of many months, during which time she has had these extensive alterations made.

The "Zafiro" was at Manila with Dewey in the Spanish American war, where she was used as a collier. From there she drifted into the freighting trade, being propelled with steam. She is 138 feet long and has a beam of 32 feet. She was later condemned because of her age and the condition of her engines. The demand for bottoms arising from war conditions caused her purchase by the Robertson Godson company of Vancouver, B. C., who made an inspection of the ship and who decided to make the necessary alterations to make the vessel seaworthy. A complete remodeling took place, her boilers and bunkers were removed and in their place a 350 b. h. p. direct reversible Atlas Diesel engine, made by the Atlas Gas Engine company of Oakland, Cal., was installed. Her steel hull is now sheathed with wood.

This engine, which has been described before in Motorship, is of 6 cylinders 12"x16", which develops her rated power at 220 r. p. m., with a fuel consumption of 427 lbs. per h. p. hour.

A complete description with diagrams and cuts of the Atlas Diesel engine as installed aboard the "Bowler" will be printed in an early issue of Motorship."

O. E. Nilsen, the Northwest sales manager for the Atlas-Imperiol Gas Engine company, arranged for the sale of the "Bowler's" engines. Mr. Nilsen has also secured orders from the Lyall Shipbuilding company of North Vancouver, B. C., for six 175 b. h. p. Atlas Diesel engines for three wooden vessels to be built at the yards of the company for their own account. They will be 245 feet in length, 46 feet wide and will have a moulded depth of 22 feet, and will be rigged as five-masted topsail schooners.



OPERATING SIDE OF THE "BOWLER'S" 350 B. H. P. ATLAS DIESEL ENGINE

NEW CONCRETE MOTORSHIP YARD.

The Bergsunds A. B., builders of the "Original" surface-ignition type of marine heavy-oil engines, has laid down a new yard at Gothenburg, Sweden, for the construction of standardized concrete motorships. The first of a number has been commenced, and this series will consist of vessels of 600 tons d. w. c.

MORE BOATS FOR KLAWAK CANNERY.

W. T. Hale, superintendent of the North Pacific Trading & Packing company's cannery at Klawak, Alaska recently returned to San Francisco after a visit in Seattle, where he purchased a number of boats. The purchases included the purse seiners New Rochelle, Rival, Mary P. and Comanche.

CONCRETE SHIPS

A contract to build concrete ships has been made by Swan, Hunter & Wigham Richardson, Ltd., of England with the Wear Concrete Building Co., a new company with a capital of $350,000.00. Seeing that Swan, Hunter & Wigham Richardson are builders of Diesel engines and motorships, we should not be surprised to see them construct concrete motor-vessels.

AUXILIARY MOTORSHIP-BUILDING IN AUSTRALIA.

At the yard of Hobart Shipbuilding & Shipowning Co., Hobart, Australia, an auxiliary motor schooner has been laid down which is being constructed of Tasmania timber. She will be 141 ft. long by 30 ft. beam and 11 ft. moulded depth. A heavy-oil engine is to be installed.

A 450-ton displacement Diesel-driven concrete motor-vessel is being built by La Société Construcciones y Pavimentos of Barcelona. A Diesel engine of 120 b. h. p. is being installed. Shortly concrete ships of 1,500 d. w. c. will be built at this yard.